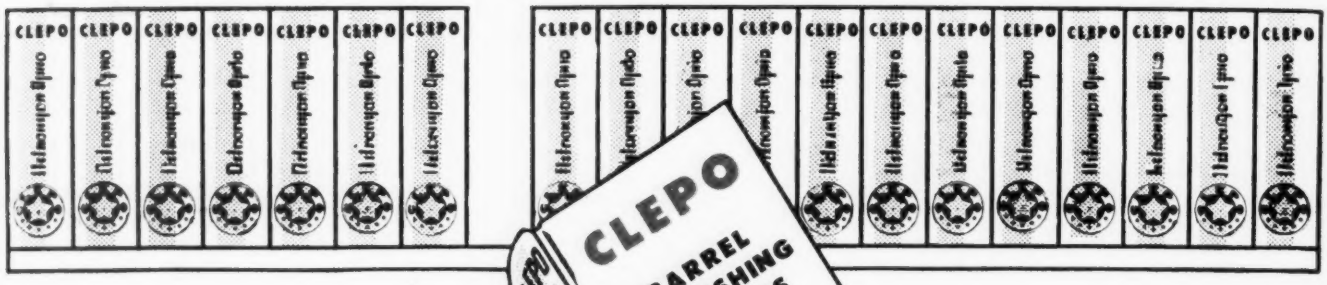
SEPTEMBER, 1956

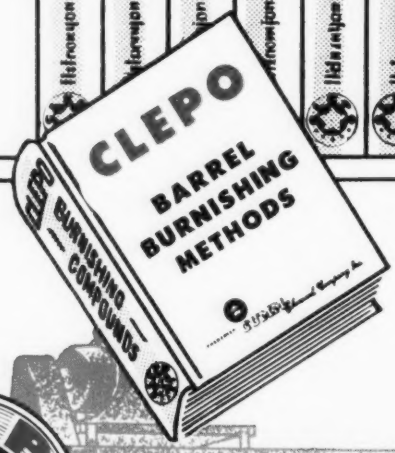
METAL FINISHING

DEVOTED EXCLUSIVELY TO METALLIC SURFACE TREATMENTS

FOUNDED 1903

LIBRARY OF CLEPO SERVICE





CLEPO
METAL FINISHING CLEANERS AND PROCESSES

3 CLEPO COMPOUNDS

For Better Bright Burnishing

161-P for brass, aluminum, copper, steel, etc.

164-Z for zinc-base die castings

202 SPECIAL recently developed purposely . . .

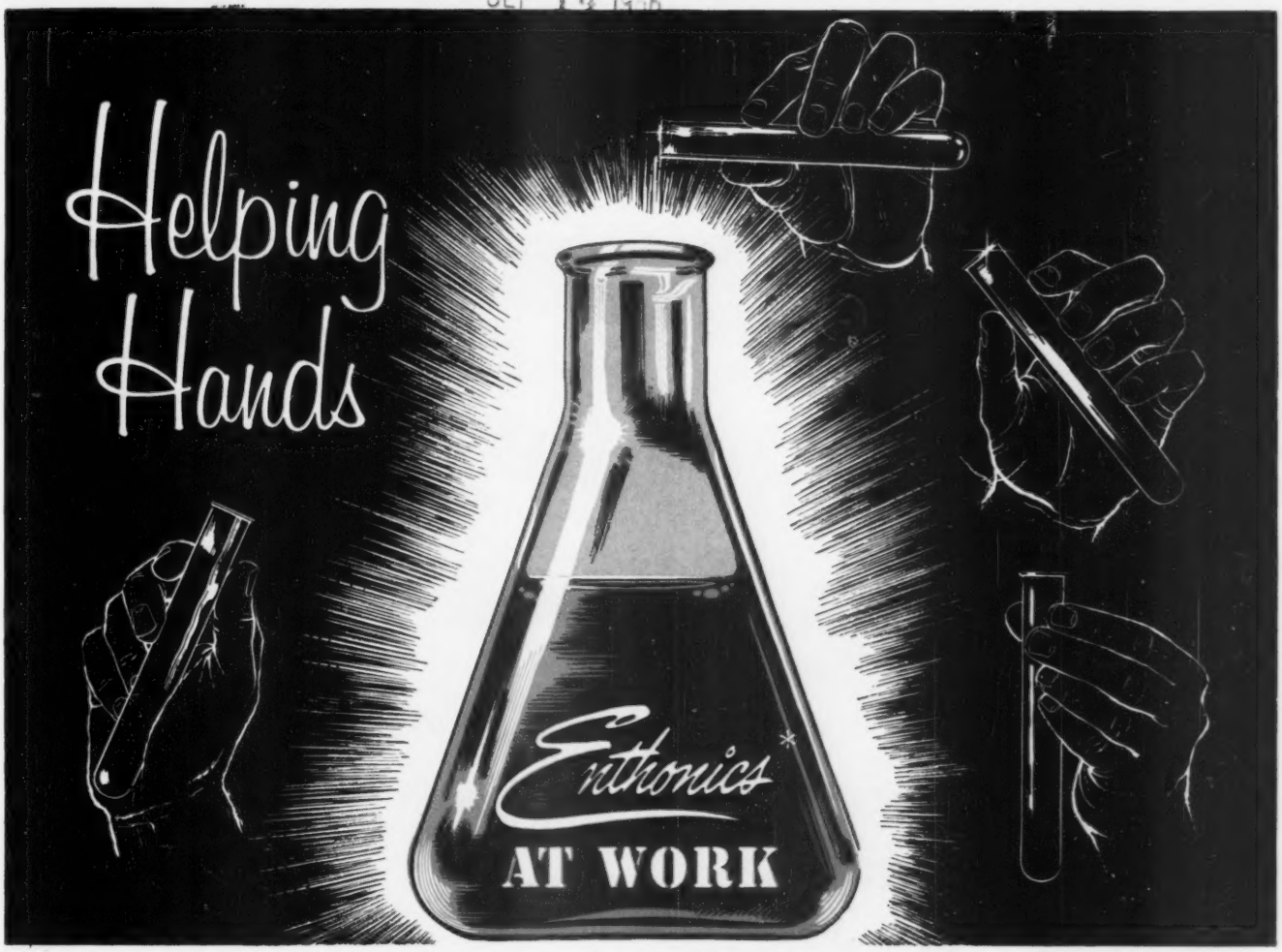
. . . to produce high luster on brass parts; also suitable for all other metals except zinc or lead base castings.

These CLEPO Compounds account for three of our extensive lines of burnishing compounds, each being formulated to give best specified results on certain metals only. No single compound can do an A-1 job on all metals and produce any finish desired. CLEPO 202 Special, for example, was formulated to produce highest luster but at the same time eliminate the danger of tarnish stains on either the work or steel balls should the load be left in the barrel for any length of time. Other compounds, not being so inhibited, can cause such stains.

We suggest that if you are doing *any* barrel burnishing, you ask our Field Service Man to check your production methods and materials. Backed by many years of experience in this very line of work, perhaps he can be of help.

FREDERICK GUMM *Chemical Company Inc.*

538 FOREST STREET, KEARNY, N. J.



FROM THOUSANDS of TESTS . . .

. . . *come the solutions to your metal finishing problems.*

If *you* are looking for creative chemistry to supply new methods for the improvement of metal finishing, look to the leader – ENTHONE. Write for the answers to these problems, identifying them by number. If your specific problem is not listed, Enthone will gladly help to find the answer.

1. HOW TO BLACKEN copper, brass, zinc, steel and other metals to meet U.S. Government specifications.
2. HOW TO STRIP NICKEL from steel without etching the steel.
3. HOW TO STRIP NICKEL from copper and brass without attacking the part.
4. HOW TO SHED WATER from metals to prevent staining or spotting during drying.
5. HOW TO TRAP FUMES from hot sulfuric acid pickles.
6. HOW TO STRIP SYNTHETIC ENAMELS from aluminum and other metals without attacking the metal.
7. HOW TO CLEAN AND REMOVE RUST AND OXIDES from steel in one operation without acids.
8. HOW TO RINSE AND DRY STEEL WITHOUT RUSTING, using cold or hot water.
9. HOW TO SHORTEN ALKALI CLEANING TIME for steel to 15 seconds.
10. HOW TO REMOVE SOLID DIRT AND OIL from metals.
11. HOW TO STRIP LEAD, TIN or soft solder from copper and brass with no etching.
12. HOW TO PLATE METALS upon aluminum.
13. HOW TO REMOVE EXCESS SILVER SOLDER chemically from silver brazed steel parts.
14. HOW TO MAKE PAINT STICK to brass and zinc.
15. HOW TO SOLVENT-CLEAN parts and assemblies with cold non-hazardous solvent.
16. HOW TO OVERCOME CHROMIC ACID CONTAMINATION in cleaners.
17. HOW TO PREVENT STAINING of chromium plate.
18. HOW TO GIVE ZINC AND CADMIUM high salt spray resistance.
19. HOW TO COLOR ALUMINUM in one operation.
20. HOW TO STRIP METAL COATINGS from zinc die castings.

The Scientific Solution of Metal Finishing Problems.

ENTHONE INCORPORATED

METAL FINISHING PROCESSES
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ELECTROPLATING CHEMICALS

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Now...look what you can do with rinse water...and NEW

By adding a mere ¼ to 2% by volume of Oakite RINSITE, you work wonders with your final rinse water.

RINSITE keeps a sparkle on your plated and polished work in two ways... (1) by promoting more complete, uniform draining for spot-free dry down; and (2) by leaving an invisible film to protect certain types of plating against rust and discoloration.

Tumbled work, too, will keep its burnished finish when rinsed with Oakite RINSITE. Barrel-finished steel parts come out of the rinse water with full lustre and shielded temporarily against rust.

Folder—F9822 tells the complete story. Get your free copy today. Oakite Products Inc., .. Rector Street, New York 6, N. Y.

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OAKITE
MATERIALS · METHODS · SERVICE
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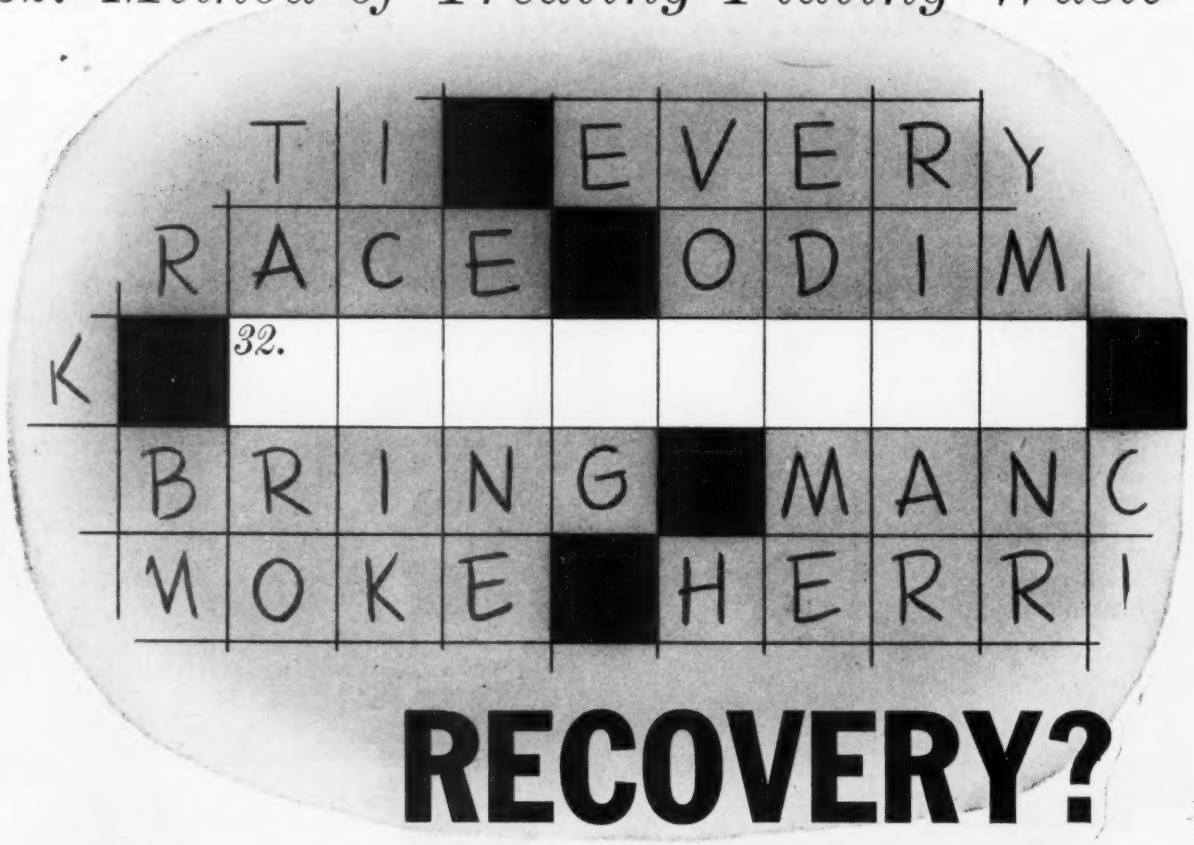
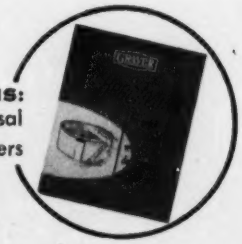
32. Method of Treating Plating Waste



RECOVERY? DISPOSAL?

There is no one process that will solve all plating waste problems. Experience has shown staff and consulting engineers that the correct solution can be obtained only by thoroughly evaluating all the factors in each case.

Whether the answer is recovery, disposal or a combination of both, Graver has complete equipment to do the job. Graver's 50 years of liquid treatment experience has resulted in equipment of advanced designs and engineered flexibility to suit individual requirements.



WRITE FOR TECHNICAL ARTICLE AND BULLETINS:
T-136: Plating Waste Solutions; Recovery or Disposal
WC-103A: Reactivators • WC-111: Ion Exchangers

GRAVER®

Industrial Waste Treatment Dept: W-211
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Division of Graver Tank & Mfg. Co., Inc.
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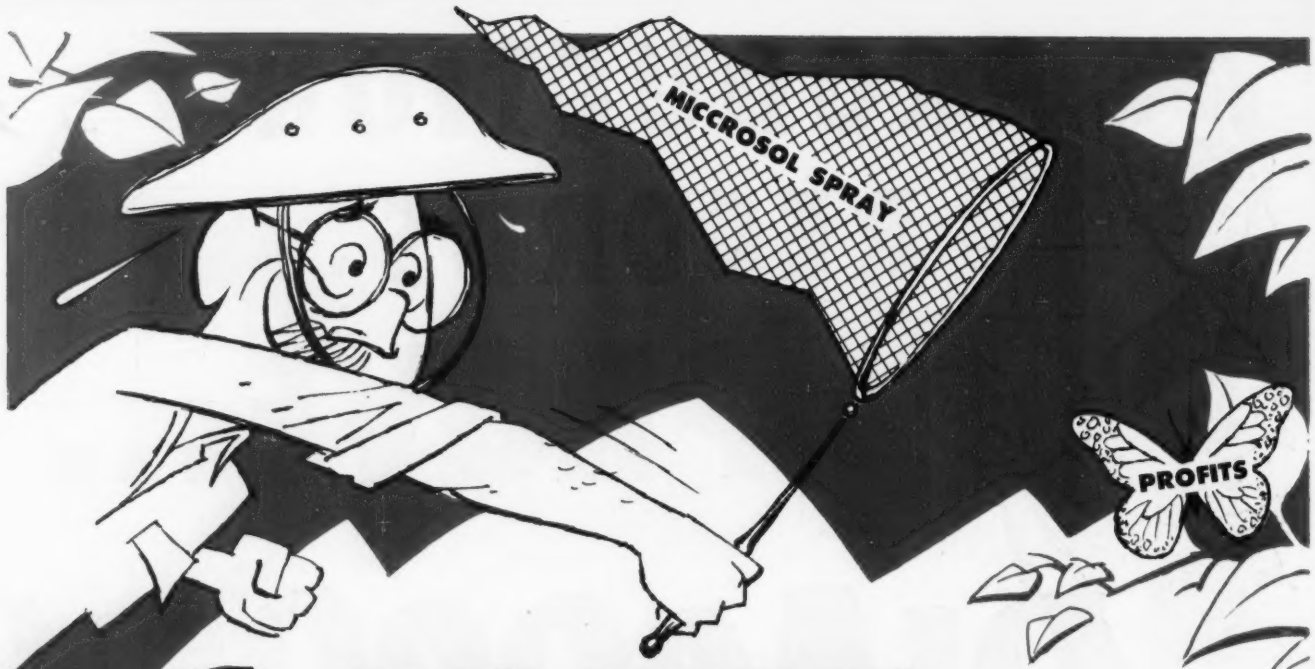


DON'T HESITATE!

MICCROSOL SPRAY S-2003 IS READY . . . to show YOU the way to profitable spray jobs

You can apply S-2003 with conventional spray equipment.

You can apply 60 mils thickness in one application without sagging of material. If multiple coats are required, a short cure time is all that's needed between applications. A contrasting color can serve for layer identification, if desired.

You can use S-2003 in all plating baths. It has the same toughness—chemical, corrosion, and abrasion resistance as Miccrosol E-1003. Our adhesive systems provide outstanding adhesion to metal surfaces.

Tanks
Ducts
and other
Equipment

Solvent additives are not necessary. S-2003 is 100% solids and is sprayed as received. Time consuming and expensive adjustments are unnecessary. Problems of material instability and film cracking are eliminated. There is no solvent loss and less operator fatigue with Miccrosol Spray S-2003.

It's the ideal plastisol for spray applications.

IT'S TOPS!

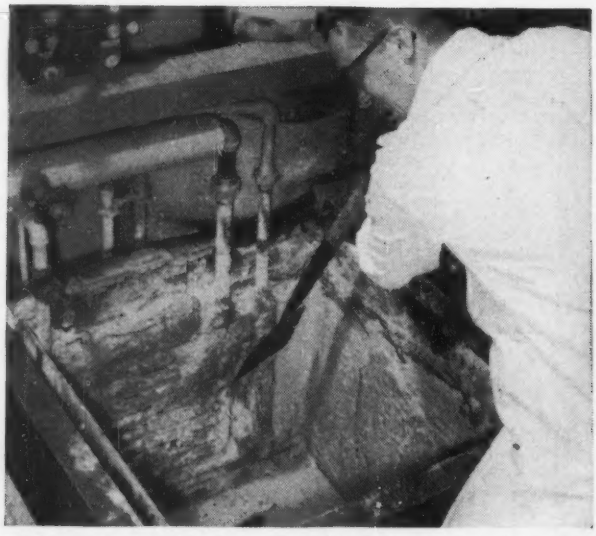
• *WRITE FOR PARTICULARS ON COMPANY LETTERHEAD*

Developed and manufactured by experienced platers

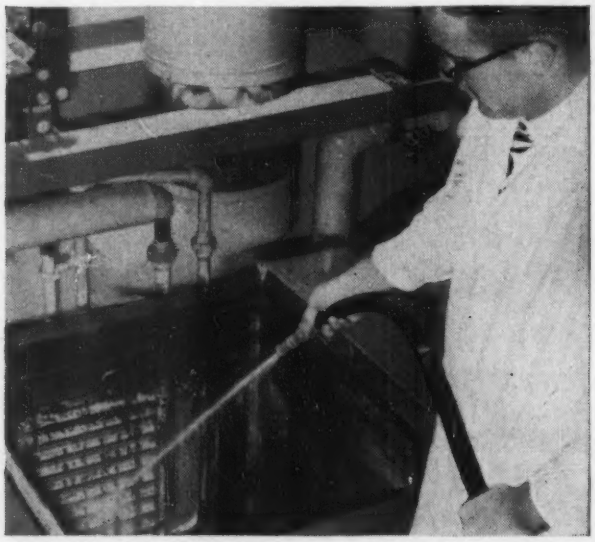
MICHIGAN CHROME *and Chemical Company*

8615 Grinnell Avenue • Detroit 13, Michigan

Introducing a new aluminum ...reduces maintenance costs... ...MIL-



Ordinary caustic solution causes build-up of scale on tank interior. Scale must be chipped off frequently.



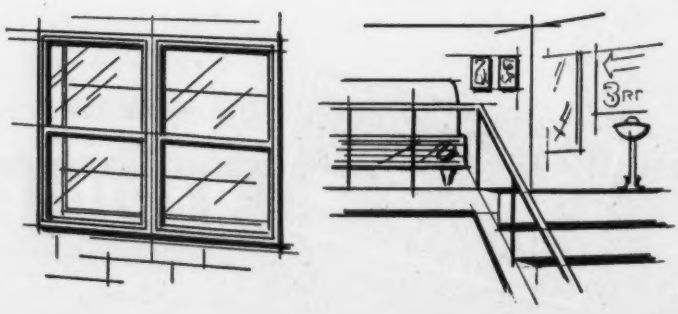
New Wyandotte Mil-Etch suspends dissolved aluminum in solution. No scale develops throughout entire life cycle.

Here's a brand-new caustic-type aluminum etchant that eliminates expensive shutdowns, needless maintenance and labor costs. Mil-Etch keeps dissolved aluminum in solution—prevents it from forming a hard scale that must be chipped from tank walls.

Etches rapidly and uniformly. Economically concentrated, Wyandotte Mil-Etch produces an attractive, uniform, high-quality etch in only a few minutes on aluminum extrusions, wrought sheets and bar stock. You can also use Mil-Etch for deep etching or chemical milling of aluminum alloys.

Easy to use. Mil-Etch is nondusty, will not cake

Use Mil-Etch for



etchant that eliminates scale produces a bright matte surface

ETCH !

in drums; it develops a low-level foam blanket to prevent excessive fuming. You can use a tank of Mil-Etch until it becomes "loaded" with dissolved aluminum.

Desmutting. For brightening aluminum alloys that turn dark in alkaline etching processes, try Wyandotte 2487. It is safer than ordinary acid solutions, and permits a closer control of the desmutting bath. Being in easy-to-handle granular form, solution make-up and additions are simple.

For full information on how new Mil-Etch and Wyandotte 2487 will solve your aluminum-etching problems, call your Wyandotte representative.

Wyandotte Chemicals Corporation, Wyandotte, Mich. Also Los Nietos, Calif. Offices in principal cities.

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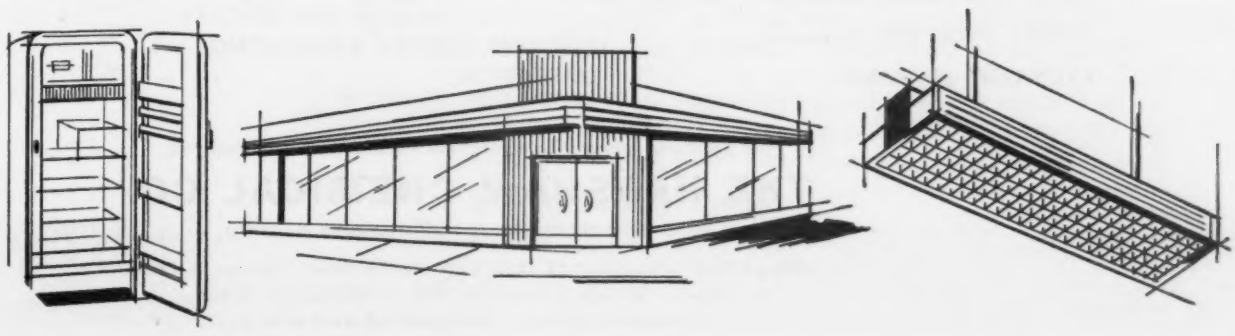
Wyandotte CHEMICALS

J. B. FORD DIVISION

etching all aluminum surfaces



LASALCO'S DAW JUNIOR FULLY AUTOMATIC PLATING MACHINE

AUTOMATIC UNLOADING! Only plating machine built from which work is unloaded from racks or wire fingers without operator's attention.

AUTOMATIC SELECTIVE CYCLING! Completely automatic by-passing of tanks, or any type of combination cycle can be arranged on the Daw Junior.

COMPLETELY VERSATILE! Individual tanks and carrier sections may be quickly removed to shorten machine—or added to lengthen machine. Can be easily installed to fit any unusual or limited floor space. The Daw Junior requires extremely low headroom.

SAVES PLATING TIME! Continuously moving cathode permits plating at higher current density thus reducing plating time far below machines with intermittent movement.

MINIMUM DRAGOUT! Automatic cam lift between tank-to-tank transfers eliminates solution dragout to absolute minimum regardless of shape or size of workpiece.

MONEY MAKER! Daw Junior has proved itself one of the most efficient machines ever developed for plating small and medium size parts with utmost speed and economy.

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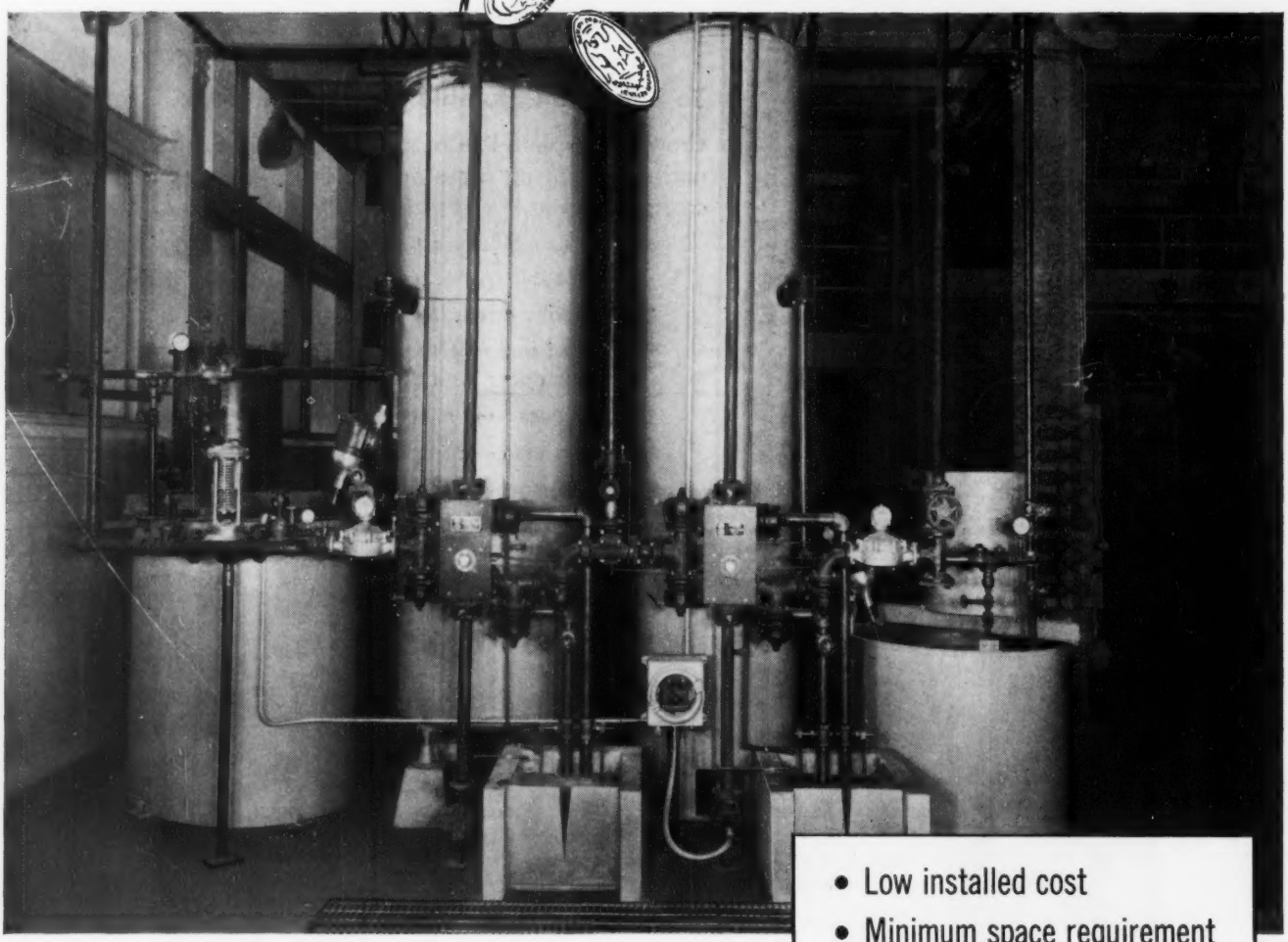

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New ion exchange techniques using "CATEXER" "ANEXER" plants make it practical to recover valuable chemicals and rinse waters in some cases. Only careful evaluation will show whether recovery methods, or treatment by oxidation, reduction or precipitation is more economical. INFILCO manufactures all types of waste treatment equipment and can offer impartial evaluation of your problem. Write for complete information.

INFILCO

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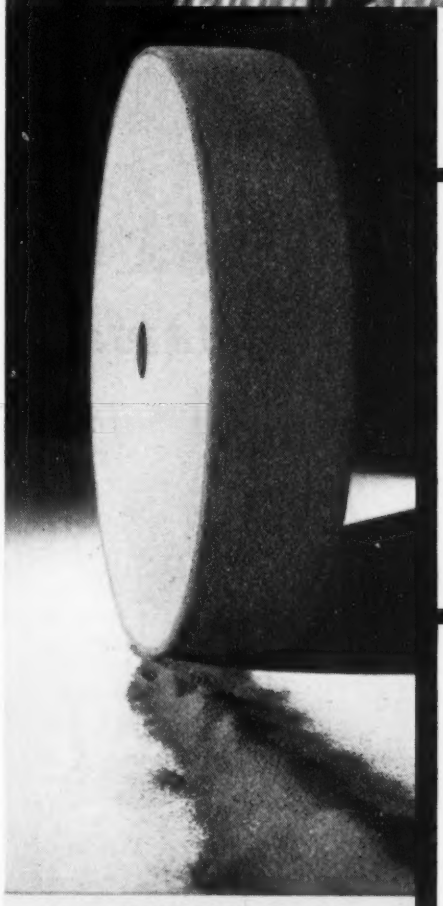
INFILCO INC. 912 South Campbell Ave., Tucson, Arizona
Offices in principal cities in North America 5539

You polish with the "Touch of Gold" when your wheels or belts are coated with ALUNDUM B abrasive. This extremely hard, sharp grain cuts fast, clean and cool. And the Norton special high capillarity treatment means easier wetting with cement or glue — for maximum adhesion, longer wheel life and better polishing performance.



Norton ALUNDUM B abrasive consists of grains of uniform blocky shape. No flats, slivers or undersize grains to loaf on the job. No oversize grains to mar surfaces. Made in all grit sizes, from 20 through 240, to cover the widest range of polishing operations.

More, and better, polishing with every set-up

ALUNDUM B abrasive brings the cost-cutting, value-adding "TOUCH OF GOLD"*

Ask Your Norton Distributor for the booklet "Setting Up Metal Polishing Wheels and Belts." Or write to the nearest district office of NORTON COMPANY, Worcester 6, Mass. Distributors in all industrial areas, listed under "Grinding Wheels" in your phone book, yellow pages. Behr-Manning Company, Troy, N. Y., div. of Norton Company. *Export:* Norton Behr-Manning Overseas Incorporated, Worcester 6, Massachusetts.

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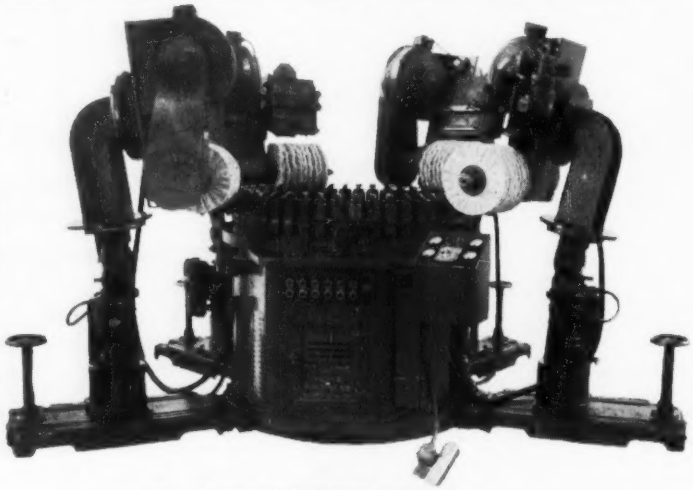
"I STILL PREFER MY FOUR-HEADED *PACKER-MATIC*"

Four or more heads on Packer automatics are the answer when polishing, buffing, or deburring production lags in your finishing room.

For handling long production runs, small odd-lot jobs or a mixture of both—Packer-Matics are easily adapted to many change-over setups, produce consistently better finishes in a fraction of hand operation time.

Packer-Matics are designed specifically to perform a multiplicity of jobs with an efficiency that will increase customer satisfaction and profit.



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OUR ENGINEERING STAFF INVITES YOUR INQUIRY.

PACKER-MATIC

AUTOMATIC MACHINES FOR BUFFING • POLISHING • DEBURRING

THE PACKER MACHINE COMPANY • MERIDEN, CONNECTICUT

Dow . . . industry's most complete line of chlorinated solvents

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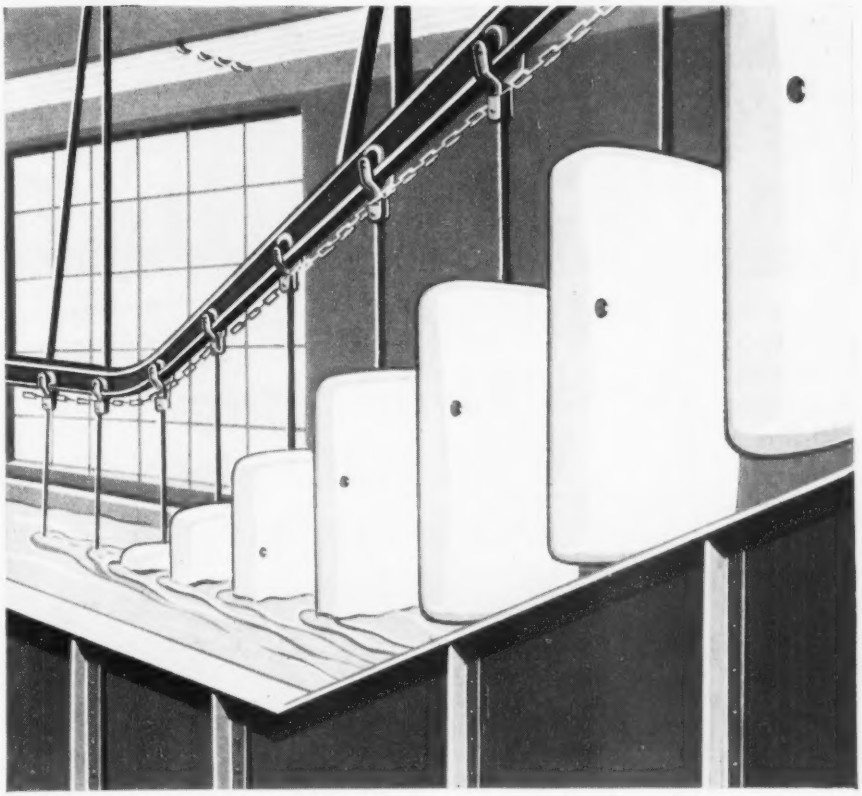

Refrigerator cabinet rejects are briefly dipped in a stripping formulation based on METHYLENE CHLORIDE for thorough removal of alkyd and epoxy resin finishes before reprocessing.

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You can strip the toughest finishes and protective coatings much more economically now. Solvent formulations based on DOW METHYLENE CHLORIDE handle in minutes jobs that normally run hours in other cleaning compounds. METHYLENE CHLORIDE *cuts* through faster, starts an even lifting action over greater areas of the part.

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Your Dow distributor can offer you unmatched service because he supplies the most complete line of chlorinated solvents . . . in addition to METHYLENE CHLORIDE, you might profitably use DOW PERCHLOROETHYLENE, DOW TRICHLOROETHYLENE, or the talk of the industry, CHLOROTHENE*. For an immediate mailing of technical and use information on any or all of these superior solvents, just return coupon to THE DOW CHEMICAL COMPANY, Midland, Michigan.

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Every Reader gets the same good impression

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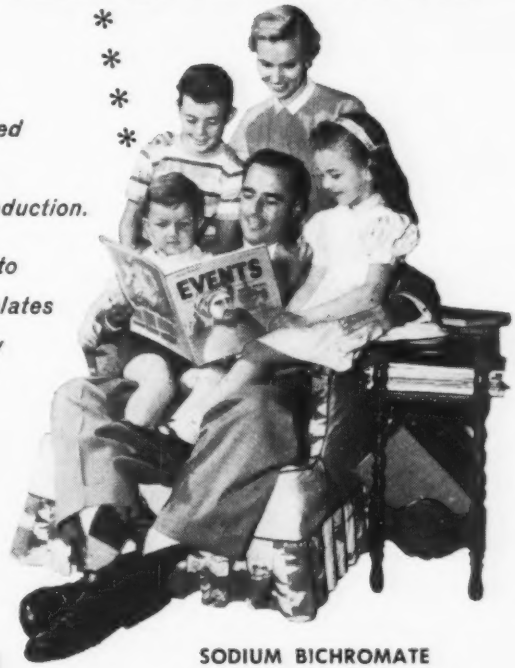
To save press down-time in replacing worn plates, and to be sure of the same fine impression on the last part of the run, plates must have surfaces that are resistant to abrasion. That's why printers use chromium-plated letterpress plates, electrotypes and gravure rolls. Then they are certain of getting clear impressions on every sheet from the first to the last.

As a manufacturer of Chromium Chemicals, Mutual is proud to emphasize their use in the American publishing field.



MUTUAL CHEMICAL DIVISION
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There is no substitute f

...in original equipment...or for replacement

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The life and efficiency of your plating equipment depends upon one vital component–the power rectifier!

HERE ARE FOUR REASONS WHY YOU SHOULD INSIST ON INTERNATIONAL RECTIFIERS...

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International Rectifier Corporation is the world's largest supplier of metallic rectifiers. Over 2,000,000, KW of power are converted daily for plating and metal finishing by International Selenium and Germanium power units. This fact, plus the knowledge that International Rectifier Corporation supplies more than half of all metallic rectifiers installed in industrial equipment, attests to the wealth of experience and know-how behind every unit produced. All units are manufactured under the highest standards of quality control in the industry.

2 HIGHER PERFORMANCE AT LOWER COST

High efficiency throughout life adds to your savings by reducing power consumption–thus lowering your plating costs. And most important of all–International Rectifiers *last longer*–a factor made possible by the development of new and better methods of manufacture.

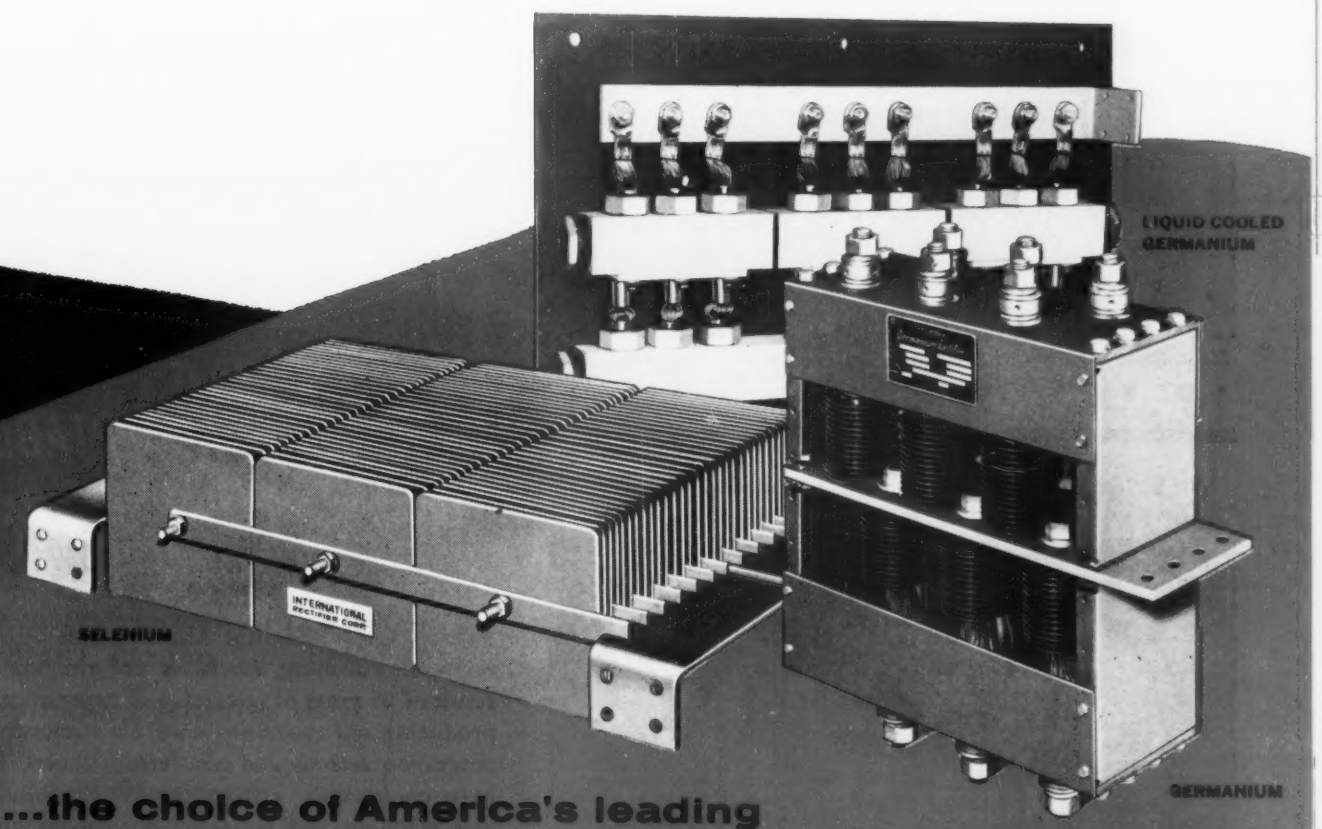
3 WIDEST RANGE OF SIZES AND TYPES AVAILABLE

Long the leader in the development of more efficient Selenium rectifiers, International recently introduced a complete line of Germanium power units, offering superior advantages to the plating industry. This progressive move highlights the diligent research and development program at International.

4 EVERY UNIT GUARANTEED

Installed in original equipment, or as a replacement, every unit is guaranteed by International to perform to the specifications set forth. This guarantee is backed by their reputation as an acknowledged leader in the field.

for EXPERIENCE!



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LOOK FOR THESE NAME-PLATES

ON YOUR RECTIFIER STACKS

Your assurance of higher efficiency, longer life—unsurpassed quality, backed by experience!

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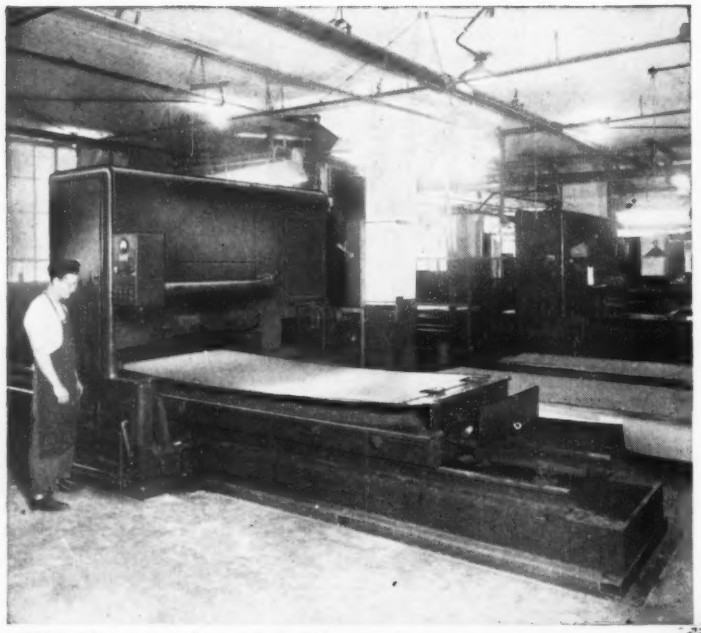
THE WORLD'S LARGEST SUPPLIER OF INDUSTRIAL METALLIC RECTIFIERS



HILL Sheet Grinder and Polisher with reciprocating hydraulic table processing individual sheets.

HILL

GRINDING and POLISHING MACHINES

How much is it costing you to produce ACCEPTABLE finishes on FLAT surfaces

HILL Pinch Roll Grinder and Polisher for "Wet" or "Dry" operations. (Shown in series for straight line production)

HILL 2-Roll Vertical Abrasive Belt Grinding and Polishing machines are the logical result of 25 years of research and experience in producing self contained units for successfully processing ferrous and non-ferrous sheets. We have consistently proven that wide abrasive belt grinding and polishing equipment must incorporate these fundamental features — rugged construction, simplicity of design, accessibility, versatility and centralized controls.

HILL abrasive belt polishing machines are recommended for continuous operation and insure lower production costs with superior finishes as required today by the manufacturers of decorative plastics, food processing equipment, automobile bumpers, lithographers and photo engravers plates, home appliances, etc., etc.

Both types of machines are normally built up to 60″ wide, and larger capacity equipment can also be furnished.

Your inquiries are solicited for detailed information and recommendations.

HILL ACME TOOLS FOR INDUSTRY

THE HILL ACME COMPANY

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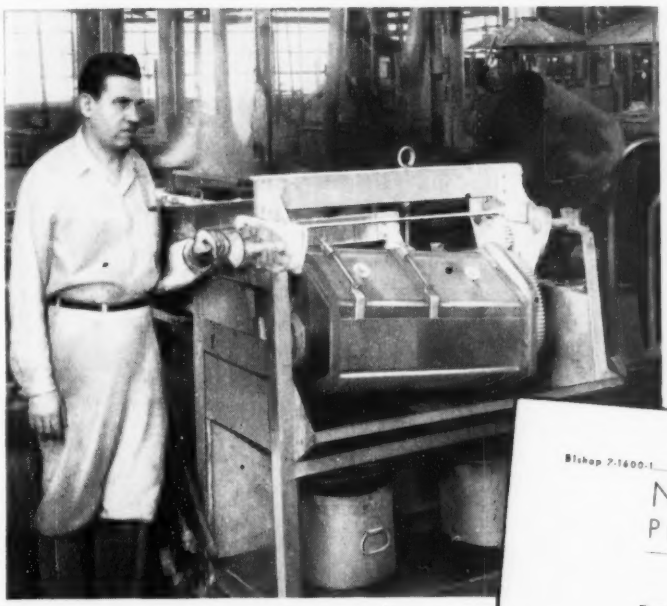
"HILL" GRINDING & POLISHING MACHINES • HYDRAULIC SURFACE GRINDERS • ALSO MANUFACTURERS OF "ACME" FORGING • THREADING TAPPING MACHINES • "CANTON" ALLIGATOR SHEARS • BILLET SHEARS • PORTABLE FLOOR CRANES • "CLEVELAND" KNIVES • SHEAR BLADES

"The New BELKE DOUBLE OSCILLATING CYLINDER



gives us

"more uniform distribution of plate according to quality control checks

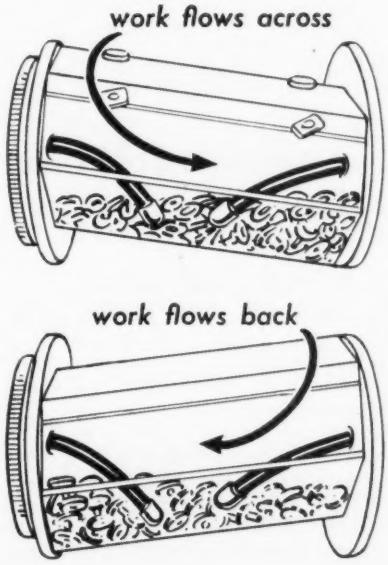
"noticeable color improvement on brass plating

"20% increase in load sizes."

Says Paul Glab,
Superintendent of Plating,
Northwestern Plating Works, Chicago.

Improved Quality Control and increased production with lower cost are a cinch with this new BELKE Plating Cylinder.

The cylinder oscillates as it rotates



Bishop 7-1600-1

NORTHWESTERN
PLATING WORKS

3114-26 SO. KOLIN AVE. • CHICAGO 23, ILL.

March 23, 1956

Belke Manufacturing Co.
947 N. Cicero Avenue
Chicago 51, Illinois

Gentlemen:

In reply to your inquiry, our Belke Double Oscillating Plating Barrel is giving much greater improvement in plating results than we had anticipated.

Quality control checks show plating thickness is much more uniformly distributed. The over plating of some parts and under plating of others, that occurs with conventional plating cylinders, is avoided.

The improvement is particularly helpful in plating washers and other flat parts which so often come through partially plated because the parts stick together.

We have used the double oscillating barrel on brass, zinc, and cadmium plating with equally good results. On brass plating work it gives a noticable improvement in color.

In addition, we have increased the load size 20% while turning out the best plating work we have ever produced.

We consider the new Belke barrel an important asset to our operation and will be glad to show it to other platers who are interested.

Very truly yours,

NORTHWESTERN PLATING WORKS
Paul Glab
Paul Glab, Supt. of Plating

all sides of all parts are equally exposed to plating current. No part of the load stays at the ends where little plating occurs. No parts stay buried with greatly reduced exposure to plating current

Do you realize that this 20% saving in plating cost is all profit you are not getting now!

Ask your BELKE Service Engineer or write for literature.

Belke Manufacturing Company
947 N. Cicero Ave., Chicago 51
EVERYTHING FOR PLATING PLANTS

FLAT POLISH

Slash production costs EIGHT ways with MICRO-POLISH

1. More square foot area can be pre-polished in a fraction of the time required for any type of contour polishing.
2. Cost per square foot is by far the lowest of all methods.
3. Use of lower steel grades rather than higher finishes give larger initial stock saving.
4. Improves press and die action.
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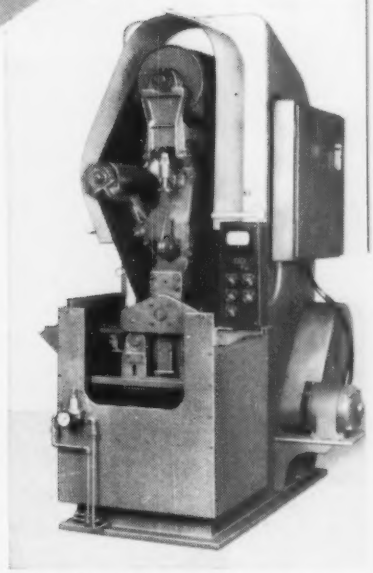
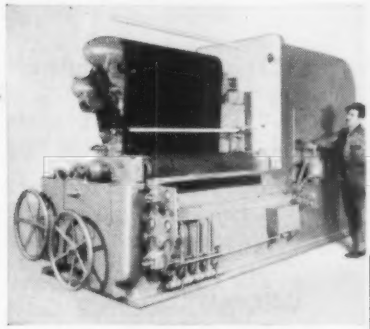
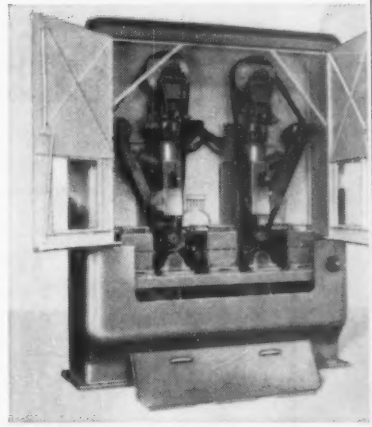


Small unit for polishing narrow strip or sheet stock.



A Micro-Polish giant used in reclamation grinding of steel strip.



Space saver unit for polishing flat bar stock. Two heads and two grades of belt grain accomplish the complete job without rehandling.

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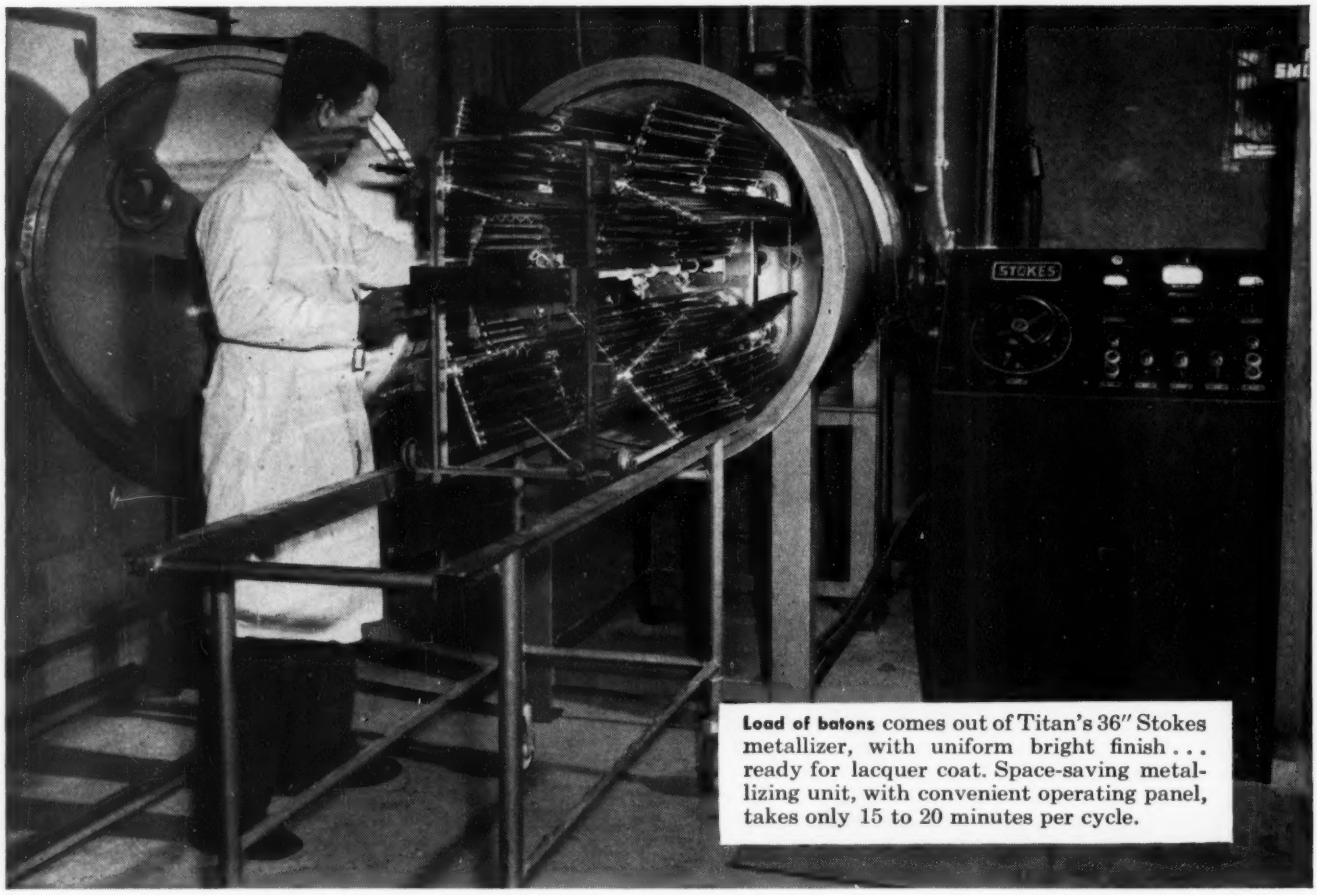

Load of batons comes out of Titan's 36" Stokes metallizer, with uniform bright finish . . . ready for lacquer coat. Space-saving metallizing unit, with convenient operating panel, takes only 15 to 20 minutes per cycle.

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...excellent corrosion resistance

minimizes need for nickel

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. . . For more information about Battelle-developed processes, get in touch with any of these authorized Battelle Development Corporation distributors. Each is fully equipped to give you complete data and technical help.

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A wide range of finishes is available. Gives products new sales values. Extraordinary smoothing action produces a micro-polished effect. "True metal color" is achieved with a lustre not attainable with belts or wheels. Metal surfaces remain undamaged.

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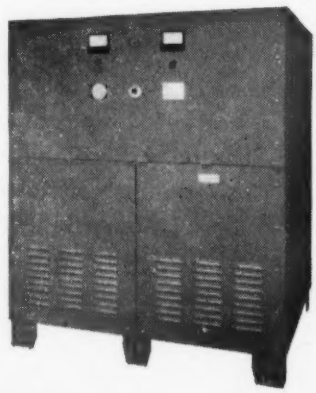

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(above) Reprinted courtesy Factory Management and Maintenance, July, 1956, Page 94, "Putting Big-Time Ideas to Work" (at Colson Corp., Elyria, Ohio)

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Colson Switched to G-S Belt-Drive Barrels . . . Cut Time, Costs and Improved Quality

"When a production man can see a way to save manhours, and money while producing a better product, he's always interested" said Jack Davis, Plant Manager of Colson Corp., Elyria, Ohio. "We changed over our plating line to G-S Barrels for cadmium and zinc. Now, after 3 years, our figures show manhour savings, and practically no maintenance costs or replacement of equipment.

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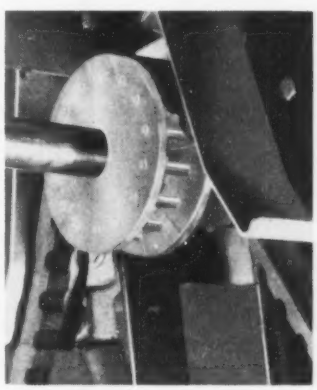

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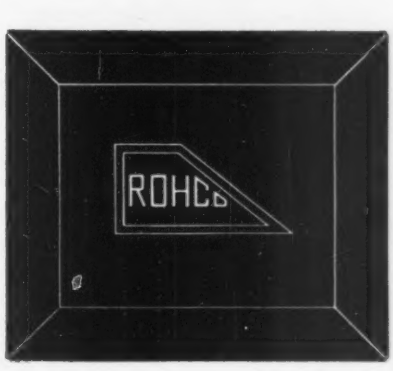

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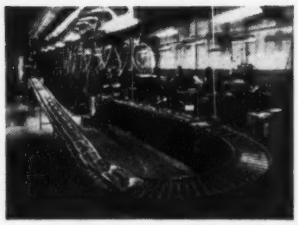

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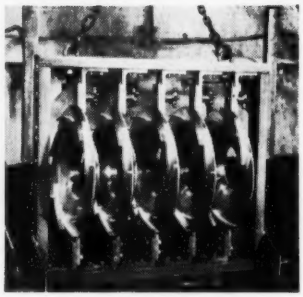

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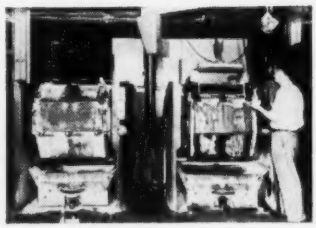

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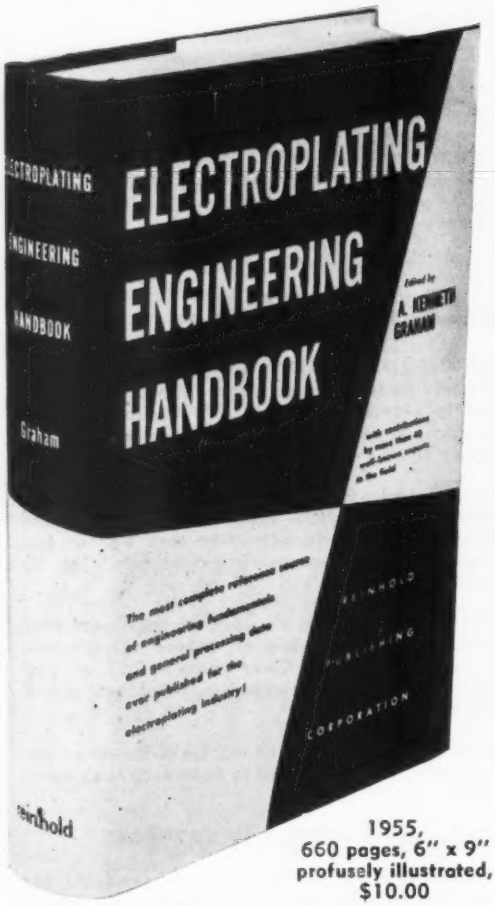

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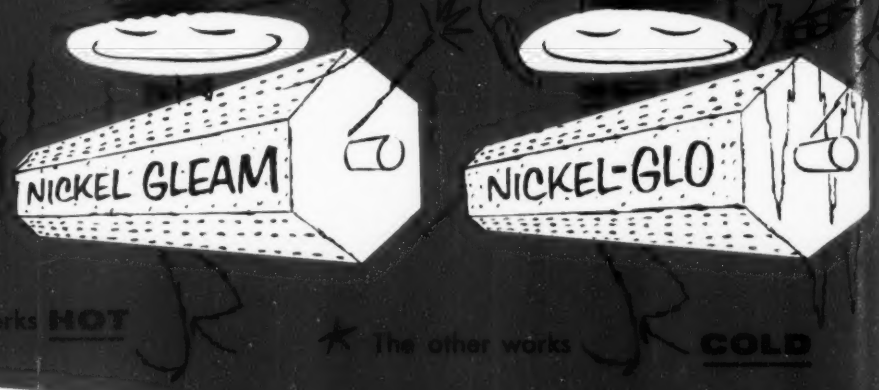

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by Ben P. Sax

President, American Buff Company

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Sincerely,

Ben P. Sax


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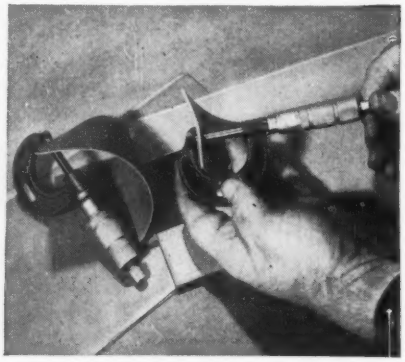

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An unusually wide line of Unichrome Dips for zinc plate, die castings, and cadmium has been made even more inclusive by three new additions to the line. Two of the new compounds are the dry, or powder, form for extra economy in shipping and handling. The third is a wet compound which facilitates solution mixing. All, however, work at extreme dilutions.

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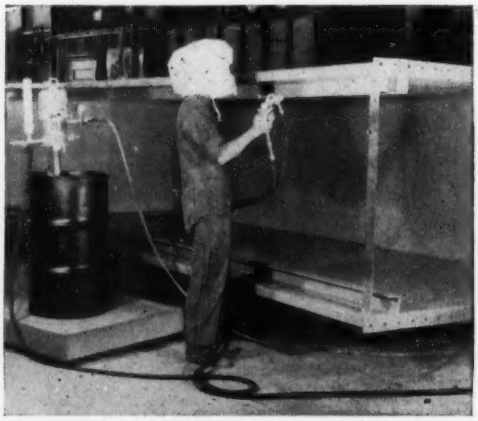
Metal & Thermit will gladly recommend the proper dip to meet specific needs. Simply submit details of the product and the requirements.

Plastisols ideal for protecting tanks

Because of its thickness, chemical inertness and sprayability, the new Unichrome "Super 5300" Plastisol Coating makes a superior tank lining. It can withstand continuous contact with severely corrosive solutions, save over the cost of applying sheet-type linings, and has no seams for corrosive solutions to penetrate. Moreover, there now exist a number of strategically located companies skilled in applying Unichrome Plastisols, and which have the baking facilities to handle even large tanks. Send for names.



Large plating tanks being sprayed with Unichrome Plastisol prior to being wheeled into baking oven for curing.

METAL FINISHING

DEVOTED EXCLUSIVELY TO METALLIC SURFACE TREATMENTS

ESTABLISHED 1903 VOLUME 54 • NUMBER 9 • SEPTEMBER, 1956

Heads or Tails?

It's quite simple to tell one side of a coin from another, even if one cannot recognize which is the obverse and which is the reverse. But it's getting to be a real problem these days to make heads or tails of the numerous published reports on the results of exposure tests which often try to convince us that this or that coating is almost as good, just as good, or even a little better than good old copper-nickel-chromium, in which the middle layer is applied with a generosity considered to border on suicidal at the moment.

There was a time when the results of a salt spray test could proudly be brought forth to reinforce the argument. Then it was found that about all you learn from this test is how well a finish stands up in a salt spray chamber, which is all well and good if you are making parts which are to be used in salt spray chambers. The first shock came when cadmium plate, which was incomparably better than zinc in the salt spray test, showed up poorly by comparison in an industrial atmosphere. Then, to add to the woes of the manufacturer, the former was found to be superior near the seashore but, again, inferior when fresh sea water was employed in the salt spray test. So, we now must qualify a claim of how well a finish stands up by specifying where!

Investigations into possible alternatives for nickel-chromium decorative finishes have been stimulated in recent years by the nickel shortage, which we will not mention again this month to avoid reopening old wounds. Suggestions have included a heavy copper undercoat followed by a light nickel plate, copper-chromium followed by lacquer, tin-nickel alloy, tin-bronze, and white brass, all followed by chromium. Salt spray and atmospheric tests, according to proponents of these finishes, have indicated promising possibilities, but there still appears to be a wide divergence of opinion as to practical performance.

Like any statistics, test results can, if properly manipulated, rival the tricks of a circus contortionist. However, in the present instances, the reports have been presented by eminent and reputable researchers, not by promotors. They can be accepted at face value. But, when differing results are obtained from different qualified sources, because of inherent lack of reproducibility in the test methods, the metal finisher cannot be censured for lack of enthusiasm for any of the proposed alternative finishes.

He knows from years of experience under widely varying conditions what his nickel plate will do but, until a great deal more comparative information is forthcoming, or until a quality test is developed which can infuse confidence rather than confusion, general acceptance of an alternative finish will be understandably slow in developing.

Nathaniel Hall

Less Common Metals and Alloys

Electrodeposition from Aqueous Solution

By M. L. Holt, *Chemistry Department, University of Wisconsin, Madison, Wisconsin*

Introduction

THE title limits this review article to a consideration of the electrodeposition of some of the less common metals and their alloys. Just what is meant by the term "less common metals"? Are they considered less common because they are rare, or is it because they are expensive? In the recently published "Rare Metals Handbook"[1] a total of thirty-four rare or uncommon metals are included in the twenty-nine chapters. In Chapter I of this handbook the editor suggests that metals are rare or uncommon for one or more of a number of reasons such as: (a) abundance in the earths crust may be small, (b) deposits of ore in economically desirable concentrations are few, (c) properties of the element may be such that conversion to the elemental form is very difficult, and (d) the element may not have enough attractive properties or uses to create a demand for it in competition with other available materials on a cost basis. It can be said that, in the final analysis, metals are rare or uncommon primarily because of the cost factor.

Perhaps the best way to indicate the metals which are to be included in this review is to first take a look at all the elements now known as they are arranged in the periodic table. Table I gives a very convenient arrangement of the periodic classification of the elements known as the long or extended form of the periodic table. It should be mentioned that there is some difference of opinion regarding the designation of the *a* and *b* sub-groups in this form of the table; however, the plan used in Table I is logical and satisfactory. The table, as given, is simplified as much as possible for ready reference by giving the various group and period designations and then only the symbol and atomic number of each element. The atomic number of an element is usually defined as the number of protons in the nucleus of the atom, or as the total number of electrons arranged in the various electron

TABLE I. ***Long or Extended Form of Periodic Table***

Number given under each symbol is atomic number of that element.

	Ia	IIa	IIIb	IVb	Vb	VIb	VIIb	VIII			Ib	IIb	IIIa	IVa	Va	VIa	VIIa	O
1	H																H	He
	1																1	2
2	Li	Be											B	C	N	O	F	Ne
	3	4											5	6	7	8	9	10
3	Na	Mg											Al	Si	P	S	Cl	A
	11	12											13	14	15	16	17	18
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
5	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
6	Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
	55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
7	Fr	Ra	Ac	Rare earths				Ce	Pr	Nd	Pm	Sm	Eu	Gd	To	Dy	Ho	Er	Tm	Yb	Lu
	87	88	89					58	59	60	61	62	63	64	65	66	67	68	69	70	71
				Actinides				Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	E	Fm	Mv		
								90	91	92	93	94	95	96	97	98	99	100	101		

shells of the atom. It should be noted that hydrogen is included in two groups, Ia and VIIa, to emphasize the fact that it has some of the properties of elements of both groups.

The one hundred and one chemical elements now known can be classified on the basis of the electronic structure of their atoms into the following four different types: (a) the inert elements having all electron shells of their atoms completely filled, (b) the representative elements with the outermost shell incomplete, (c) the regular transition elements with the two outermost electron shells incomplete (incomplete *d* sub-shells) and (d) the inner transition elements with the three outermost electron shells incomplete. The inert elements are the noble gases of group zero of the periodic table; the representative elements are the elements of group Ia, IIa, IIb, and IIIa to VIIa; the transition elements are the IIIb to VIII, and Ib groups of elements except the rare earths (numbers 57-71) and the actinides (numbers 89-101) of group IIIb which are the inner transition elements. It should be mentioned that, according to some definitions, the group Ib elements are not considered to be transition elements.

Most of the regular transition elements and a number of other elements have been electrodeposited from aqueous solutions according to the literature reports which are summarized in Table II. Some of the reported results are rather questionable and, in the table, these are indicated by a question mark following the symbol of the element. Without doubt some of the rare earths and actinides have been electrodeposited from aqueous solution, but these metals are omitted from Table II and are not included in this discussion. An excellent summary of the published results describing the electrodeposition of many of the uncommon metals is given in the new edition of "Modern Electroplating."[2]

TABLE II. ***Metals Which, According to Literature Reports, Can Be Electrodeposited from Aqueous solutions.***

IVb	Vb	VIb	VIIb	VIII			Ib	IIb	IIIa	IVa	Va	VIa
Ti?	V?	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se
Zr?	Nb?	Mo?	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te
Hf?	Ta?	W?	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po

Only fifteen or so of the elements that can be electrodeposited from aqueous solution are of real interest and importance in the electroplating field at the present time and these are summarized in Table III. Manganese is in this group because, although it is of little importance in electroplating as such, the electrolysis of manganese(II) solutions has application in the electrowinning of manganese.

The purpose of this review article is to summarize and evaluate the available information dealing with the electrodeposition of some of the less common transition metals and their alloys. The discussion will be limited to the electrodeposition of the metals of periodic table groups IVb, Vb, VIb and VIIb and will also be limited to aqueous solutions. Most of these metals

TABLE III. ***Metals Which Can Be Electrodeposited from Aqueous Solutions and Which Are of Some Importance in Electroplating***

VIb	VIIb	VIII			Ib	IIb	IIIa	IVa
Cr	Mn	Fe	Co	Ni	Cu	Zn		
			Rh	Pd	Ag	Cd	In	Sn
				Pt	Au			Pb

are usually considered uncommon metals and also, of course, they are classified as transition elements. They are called transition elements because they have incomplete *d* electron sub-shells; it is these *d* sub-shells which are being filled as atomic number increases in progressing to the right in a given period of the periodic table. For example, referring to Table I period 4, we find the elements titanium, Ti, atomic number 22 and vanadium, V, atomic number 23. The $_{22}$Ti atom has the structure $1s^2$, $2s^22p^6$, $3s^23p^63d^2$, $4s^2$ and the $_{23}$V atom has the structure $1s^2$, $2s^22p^6$, $3s^23p^63d^3$, $4s^2$. The only difference in these structures is in the number of electrons in the $3d$ sub-shell with titanium having 2 electrons ($3d^2$) and vanadium having 3 electrons ($3d^3$). The d sub-shell of course has a capacity of 10 electrons and is not filled until we go on in the fourth period to $_{29}$Cu with the structure $3d^{10}$. In many cases the total number of electrons in the outer *d* and *s* sub-shells gives the maximum oxidation number (valence) of the element in its compounds. Variable oxidation number is of course a characteristic of these elements and of the rest of the transition elements. These metals also have other common characteristics of the transition elements such as the property of forming numerous colored ions and compounds, of forming complexes with many other compounds and ions, and of serving as catalysts for a number of reactions.

Titanium, Zirconium and Hafnium (Group IVb)

It is very doubtful that any of these group IVb metals have been electrodeposited from aqueous solution, although reports in the literature indicate some degree of success. Numerous attempts to electrodeposit titanium and particularly zirconium[3] have been carried out in this laboratory without success. Among the aqueous solutions tried were: a patented bath composed of zirconyl chloride and ammonium carbonate; a zirconyl sulfate bath; various citrate and ammoniacal citrate solutions containing zirconium compounds; and a patented bath prepared from zirconium (or titanium) hydroxide and sodium hydroxide. Numerous attempts were also made to electrodeposit alloys of zirconium with iron, nickel, or cobalt but without success. Since the calculated potential, E_o, of zirconium[4] is close to the potentials of aluminum and beryllium, neither of which has been electrodeposited from aqueous solution, these failures are not surprising. Not much is known as yet about the electrochemistry of hafnium but it can be assumed that its properties are about the same as those of zirconium.

Vanadium, Niobium, and Tantalum (Group Vb)

The reports of the successful electrodeposition of the group Vb metals from aqueous solution are, in some

cases, rather definite but. again with this group as with the group IVb metals, it is extremely doubtful that electrodeposition from aqueous solution has been accomplished.

VANADIUM AND VANADIUM ALLOYS:

Some of the earlier attempts to electrodeposit vanadium from aqueous solutions are summarized by Fischer.[5] He found that previously reported successful electrodeposits of vanadium were erroneous and that the electrodeposit obtained was in some cases a platinum hydride coating on the platinum cathode. In this laboratory attempts have been made to electrodeposit vanadium and vanadium alloys.[6] In this work a citrate type of plating bath was used primarily in trying to codeposit vanadium with iron, nickel, or cobalt. A typical bath contained: 66 g./l. of citric acid, 60 g./l. of the codepositing metal sulfate (Fe, Co, Ni), 5 g./l. of sodium metavanadate, 0.5 g./l. of ammonium sulfate, and ammonium hydroxide to the desired bath pH. Electrolyses were carried out at various cathode current densities, several different bath pH values, and at an elevated temperature as well as at room temperature. *In no case was a cathode deposit of vanadium or a vanadium alloy obtained.*

TANTALUM AND TANTALUM ALLOYS:

Experimental work in this laboratory indicates that, contrary to reports in the literature, it is quite unlikely that tantalum or tantalum alloys have been successfully electrodeposited from aqueous solution. It is claimed, for example, that solutions prepared by extracting fusions of tantalum(V) oxide in potassium pyrosulfate with aqueous glucose, salicylic acid, or resorcinol, gave on electrolysis a cathode deposit of tantalum.[7] When this claim was checked in this laboratory[8] it was found that the thin cathode deposits which were obtained from baths of this type after a long period of electrolysis were actually cathode deposits of platinum which had entered the bath through corrosion of the platinum anodes. A British patent[9] proposes plating baths for the electrodeposition of an alloy of tantalum, tungsten, and nickel, and also for an alloy of tungsten and tantalum. The claims in this patent were checked in this laboratory[10] and it was found that no tantalum alloys were electrodeposited. For example, a solution which is reported to give an electrodeposited alloy containing about equal amounts of tantalum, tungsten, and nickel was found to give an alloy of only nickel and tungsten. No tantalum could be detected in the cathode deposits by either chemical or spectrographic tests. Another plating bath given in this patent, which is claimed to give an alloy of tantalum and tungsten as a cathode deposit, gave absolutely no metallic cathode deposit. Other attempts to electrodeposit tantalum and tantalum alloys, particularly alloys with iron, nickel, or cobalt, from various citrate, carbonate, and oxalate solutions were unsuccessful.

Chromium, Molybdenum and Tungsten (Group VIb)

There is a large amount of information in the literature dealing with the electrodeposition of the group VIb metals and alloys containing one or more of these metals. The plating of chromium is, of course, a common commercial process but it is quite doubtful that either pure molybdenum or pure tungsten has been electrodeposited from aqueous solution in appreciable amounts. Electrodeposition of alloys of the group VIb metals is a well established fact but, as yet, little or no practical use for these alloys has been found.

CHROMIUM ALLOYS:

In 1950 Rogers and Burr[11] reported the successful electrodeposition of alloys containing about 70% chromium and 30% tungsten. The plating solutions they described required a very high cathode current density, 140 to 280 amp./dm.^{2}, and the cathode current efficiency was reported to be only about 0.05%. Work in this laboratory with the Burr and Rogers bath[6] confirmed their results. For example, a typical bath was prepared from 200 g./l. of chromium(VI) oxide, 300 g./l. of ammonium citrate, 2.5 g./l. of ammonium sulfate, 150 g./l. of tungsten(VI) oxide and ammonium hydroxide to a pH of about 8. It should be noted that considerable care must be exercised in the preparation of this bath since chromium trioxide is a powerful oxidizing agent. When this plating bath, at 90°C., was electrolyzed at 240 amp./dm.^{2} for one hour a thin metallic deposit appeared on the copper cathode. The deposit weighed only about one mg. but it did give qualitative tests for tungsten and chromium. The platinum cathode used in the experiments showed no appreciable loss in weight as a result of electrolysis. Addition agents, such as sulfates of nickel, cobalt, and iron, had no noticeable effect on the weight or appearance of the cathode deposits.

A patent granted to C. C. Ma[12] describes a process for the electrodeposition of an alloy of chromium and molybdenum. It is claimed, for example, that an aqueous plating bath prepared from 150 g./l. of chromium (VI) oxide, 50 g./l. of molybdenum(VI) oxide and 1.5 g./l. of sulfuric acid gave, on electrolysis at 15 amp./dm.^{2}, a chromium-molybdenum alloy deposit containing 22.4% molybdenum. Work in this laboratory[13] indicates that the alloy deposits obtained from the type of bath described by Ma contain only about 1% molybdenum. The results of a typical series of runs are given in Table IV.

TABLE IV

Electrolysis of a Chromium-Molybdenum Bath

150 g./l. CrO_3, 50 g./l. MoO_3, and 1.5 g./l H_2SO_4. Temp. 40°C.; time of run 3 hrs; cathode current density 15 amp./dm.^{2}

Run Number	*Deposit Wt., g.*	*Analysis % Mo*	*% Cr*
1	0.4167	0.2	98.4
2	0.3441	0.46	99.3
3	0.2649	0.95	...

The knowledge that chromium-molybdenum alloys containing about one per cent of molybdenum could be electrodeposited from a regular chromium plating bath with added MoO_3 suggested that chromium molybdenum alloys containing a higher percentage of molybdenum might possibly be electrodeposited from other types of chromium plating baths, particularly trivalent baths, with added molybdenum compounds. Various trivalent chromium plating baths have been

reported in the literature but the one wnich appears the most successful was developed by Lloyd et al.[14] of the Bureau of Mines Laboratory at Boulder City, Nevada. This bath, which is intended primarily for the electrowinning of chromium from low grade ores, contains what is essentially ammonium chrome alum, $(NH_4)_2SO_4 \cdot Cr_2(SO_4)_3 \cdot 24H_2O$, and other minor constituents. Since the operation of the bath requires a diaphragm to separate the anode and cathode compartments, a special type of anode compartment was devised for use in this laboratory. This compartment was made of Plexiglass (2½ x 2½ x ⅜ inches) cut to a U shape, and with No. 17 Vinyon cloth cemented to both sides of the frame. A 3 cm. x 3 cm. platinum anode was suspended in this anode compartment. A small cell with a capacity of about 175 ml. was used with one anode and a copper cathode. A larger cell was fitted with two anodes, in compartments, and one cathode and contained about 300 ml. of solution. Plating solutions were maintained at about 60°C. and were stirred during electrolysis. Table V gives the composition of a typical bath used in this work.

TABLE V

Ammonium Chrome Alum-Molybdate Bath[15]

$Cr_2(SO_4)_3 \cdot 15H_2O$	200 g.
$(NH_4)_2SO_4$	250 g.
$(NH_4)_6Mo_7O_{24} \cdot 4H_2O$	varying amounts
NH_4OH (conc.)	50 ml.
Water to make	1 liter
H_2SO_4 to pH	1.7 to 2
Temperature	60°C.
Cathode current density	33.3 amp./dm.^{2}
Time of electrolysis	about 15 min.

Portions of this ammonium chrome alum-molybdate bath (Table V) were electrolyzed separately with 6, 12, and 20 g./l. of added ammonium molybdate. The cathode deposit in each case gave a qualitative test for molybdenum but the amount was estimated to be less than one per cent. This type of bath was also used in attempts to electrodeposit other chromium alloys. When 6 g./l. of $CoSO_4 \cdot 7H_2O$ were added to a sample of the bath, electrolysis gave a dark rather non-metallic deposit which contained a very small amount of cobalt. When 3 g./l. of $NiSO_4 \cdot 6H_2O$ were added to a portion of the bath, the cathode deposit was metallic in appearance and contained a trace of nickel. When about 6 g./l. of $Na_2WO_4 \cdot 2H_2O$ were added to the bath, electrolysis gave a cathode deposit which contained only a trace of tungsten.

MOLYBDENUM AND MOLYBDENUM ALLOYS:

The electrodeposition of pure molybdenum has been reported many times, perhaps most recently by Ksycki and Yntema.[16] They describe the electrodeposition of molybdenum from aqueous solutions of molybdic acid in formates, acetates, propionates, fluorides, and phosphates of sodium, potassium and ammonium. Although metallic deposits were obtained, the reported cathode current efficiencies were very low, varying from 0.5% to a maximum in one case of 2.3%. Work with baths of this type in this laboratory showed that thin rather dull metallic deposits were obtained with very low current efficiencies. It was found that molybdenum(VI) oxide is not very soluble in the suggested bath components and that foaming of the bath during electrolysis is a serious problem. It is doubtful that any of these baths will be suitable for plating molybdenum on other metals.

The electrodeposition of molybdenum-cobalt and molybdenum-iron alloys is reported in a patent issued to Yntema.[17] These plating baths were used in this laboratory and made up from directions as follows: 1 liter of water, 20 g. of Na_2MoO_4, 10 g. of $CoSO_4 \cdot 7H_2O$, or 12 g. of $Fe_2(SO_4)_3$, 250 g. of NaOH, 80 g. of Na_2CO_3 and 20 g. of dextrose. Electrolysis of the molybdenum-cobalt bath yielded alloy deposits containing from 4 to 17% molybdenum as shown in Table VI.

Electrolysis of the molybdenum-iron bath yielded alloy deposits containing from 12 to 34% molybdenum as shown in Table VII. As can be seen, the cathode current efficiency (C.C.E.) of the molybdenum-iron bath is much lower than the efficiency of the molybdenum-cobalt bath; however the percentage of molybdenum is highest in the iron alloys.

In other work the effect of added sodium molybdate on various plating baths was studied. Addition of varying amounts of molybdate had little if any effect on

TABLE VI

Effect of Temperature and Cathode Current Density (C.C.D.) on Molybdenum-Cobalt Bath

C.C.D. Amp./dm.^{2}	*Time, Min.*	*Temp. °C.*	*Deposit Wt., g.*	*% Mo in Deposit*	*C.C.E. %*	*Appearance of Deposit*
0.05	120	45	0.020	4.0	94	bright
0.11	120	45	0.024	7.5	69	light gray
1.10	25	70	0.021	12.5	25	gray matte
2.77	10	70	0.020	17.	25	dark gray

TABLE VII

Effect of Temperature and Cathode CurrentDensity (C.C.D.) on Molybdenum-Iron Bath.

C.C.D. Amp./dm.^{2}	*Time, Min.*	*Temp. °C.*	*Deposit Wt., g.*	*% Mo in Deposit*	*C.C.E. %*	*Appearance of Deposit*
0.1	60	40	0.004	12	22	bright
1.1	30	40	0.006	34	4	bright
5.5	10	40	0.005	40	4	bright
5.5	30	70	0.017	34	4	dull

TABLE VIII

Effect of Sodium Molybdate on Watts Nickel Bath.

5 min. electrolysis; temp. 50°C.; bath pH = 5; 10 amp./dm.²

Na_2MoO_4 in bath g./l.	Deposit Wt. g.	Analysis % Mo	% Ni	C.C.E. %	Appearance of Deposit
2	0.170	1.6	96.2	98	granular nonadherent
4	0.152	6.7	92.5	90	nonadherent
6	0.138	7.3	88.0	79	flaky nonadherent
8	0.071	20.0	73.7	45	flaky nonadherent
10	0.056	18.9	70.1	36	dark gray

the behavior of the regular chromium plating bath, except at high concentrations of Na_2MoO_4, but did have some effect on the Watts nickel bath, on the Kalmus cobalt bath, and on the ferrous sulfate iron bath. The effect on the Watts nickel bath, given in Table VIII shows that added molybdate decreases current efficiency and results in very poor nonadherent deposits.

A citrate type of plating bath for the electrodeposition of alloys of molybdenum with cobalt, nickel and iron was proposed by Seim and Holt[18] and a patent[19] for the process was granted. Yntema and Ksycki[20] were granted patents for the electrodeposition of molybdenum alloys from solutions containing either aliphatic acids or their salts or various fluorides. Brenner and Burkhead[21] electrodeposited cobalt-molybdenum alloys from strongly alkaline solutions containing potassium carbonate, cobalt chloride, and sodium molybdate.

The citrate type of bath for molybdenum alloys (with Ni, Co, or Fe) was studied in considerable detail by Ernst, Amlie, and Holt.[22] In previous work with this bath[18] emphasis was put on plating solutions having pH values in the range of about 3 to 9. In this later study the alloy plating solutions were maintained in the pH range of 10 to 10.5 and sodium citrate, instead of citric acid, was used as the source of citrate ion in the bath. Experimental work was organized so as to compare the behavior of each of the alloy plating baths (Mo-Co, Mo-Ni, Mo-Fe) at similar conditions of electrolysis. The plating baths were made up as follows: 0.3 mol/liter of sodium citrate, 0.3 mol/liter of the sulfate of the codepositing metal (Ni, Co, Fe), varying amounts of sodium molybdate, and ammonium hydroxide to bath pH 10.5. The effect of varying amounts of sodium molybdate on the performance of the alloy baths is given in Tables IX, X and XI. It can be seen that, as would be expected, an increase in the amount of molybdate in the bath also increases the percentage of molybdenum in the alloy deposit. Increasing the molybdate in the bath tends, in general, to decrease the cathode current efficiency of the bath.

TABLE IX

Effect of Sodium Molybdate Concentration on Iron-Molybdenum Bath.

Na_2MoO_4 in bath, M/L	Deposit Wt., g.	Analysis % Mo	% Fe	C.C.E. %
0.00	0.2184	----	98.1	18
0.02	0.1850	13.5	37.0	10
0.05	0.0927	41.4	32.5	8
0.10	0.0641	33.1	33.5	5
0.20	0.0242	52.5	28.5	2.5

TABLE X

Effect of Sodium Molybdate Concentration on Cobalt-Molybdenum Bath

Na_2MoO_4 in bath, M/L	Deposit Wt., g.	Analysis % Mo	% Co	C.C.E. %
0.00	0.1227	----	99.0	55
0.02	0.1517	16.1	79.7	60
0.05	0.1612	28.6	69.7	68
0.10	0.1424	34.1	65.5	74
0.20	0.1951	34.6	64.0	62

TABLE XI.

Effect of Sodium Molybdate Concentration on Nickel-Molybdenum Bath

Na_2MoO_4 in bath, M/L	Deposit Wt., g.	Analysis % Mo‡	% Ni	C.C.E. %
0.00	0.2153	----	100.0	65
0.02	0.2646	2.5	97.5	82
0.05	0.2507	4.9	95.1	78
0.10	0.2433	8.1	91.9	77
0.20	0.2097	17.2	82.8	69

‡By difference.

The alloy deposits obtained from the citrate bath[22] were metallic in appearance except for a few of the iron-molybdenum alloys. All of the deposits contained cracks and some of the brighter plates had a spider web appearance. Adhesion of the alloy deposits to flat cathode surfaces was usually fairly good but, when the alloys were deposited on steel rods, or on copper or brass tubing, the adhesion was poor. The deposits on tubes or rods were easily rubbed off in flake or powder form but, in a number of cases, a very thin layer adhered to the basis metal with the bulk of the deposit separating from this thin coating and not from the basis metal. The alloy deposits on copper sheet cracked when bent once, 90° or 180°, thus exposing the basis metal. The cobalt alloy withstood the bending test better than the iron alloys but not as well as the nickel alloys. The rather poor characteristics of most of these electrodeposited molybdenum alloys may be due to the hydrogen which was deposited with the alloy. Absorbed hydrogen perhaps causes stresses and results in the cracked nonadherent nature of the alloy deposits.

TUNGSTEN AND TUNGSTEN ALLOYS:

The electrodeposition of tungsten has been reported many times but it is doubtful that pure tungsten in appreciable amounts has, as yet, been obtained as a cathode deposit during the electrolysis of aqueous solutions of tungsten compounds. This writer has shown that some of the reported tungsten cathode deposits

were, in reality, deposits of alloys of tungsten and iron, due to the presence of iron as an impurity in the substance used for preparing the plating solutions.

Alloys of tungsten, particularly with iron, nickel, or cobalt, can be electrodeposited from a number of different types of aqueous plating baths. Among the most important types may be mentioned: (a) strongly alkaline carbonate-tungstate solutions containing small amounts of iron, nickel, or cobalt compounds,[23] (b) regular iron, nickel, or cobalt plating baths containing varying amounts of sodium tungstate,[24] (c) the fluoride baths described in the patents of Armstrong and Menefee,[25] and (d) solutions containing an organic complexing agent such as a citrate or a tartrate, sodium tungstate, and a compound of a codepositing metal[26, 27]. The plating solutions used in most of the more recent work with tungsten alloys belong to this last type.

Most recent work reported from this laboratory uses the ammoniacal citrate bath which is satisfactory for the electrodeposition of tungsten-nickel, tungsten-cobalt, and tungsten-iron alloys. A bath for tungsten-nickel[28] alloys is composed of: 20 g./l. of $NiSO_4 \cdot 6H_2O$, 50 g./l. of $Na_2WO_4 \cdot 2H_2O$, 66 g./l. of citric acid, and NH_4OH to give a bath pH of about 8. When this bath was used at 70°C. and a cathode current density of 7 to 15 amp./dm.^{2} the bright cathode deposit contained about 35% tungsten and the cathode current efficiency was 40 to 45%. A plating bath proposed for tungsten-cobalt alloys[29] is composed of: 60 g./l. of $CoSO_4 \cdot 7H_2O$, 70 g./l. of $Na_2WO_4 \cdot 2H_2O$, 66 g./l. of citric acid, and NH_4OH to pH about 7. Electrolysis of this bath at 70 to 90°C. and with a cathode current density of 10 to 15 amp./dm.^{2} gave a bright cathode deposit containing about 50% tungsten with a cathode current efficiency of about 25%. One of the plating baths proposed for tungsten-iron alloys[30] is composed of: 50 g./l. of $Na_2WO_4 \cdot 2H_2O$, 2 g./l. of iron [50% Fe(II) and 50% Fe(III)], 66 g./l. of citric acid and NH_4OH to pH about 8. Electrolysis of this bath at 70°C. with a cathode current density of about 5 amp./dm.^{2} gave a cathode deposit containing about 50% tungsten with a cathode current efficiency of about 25%.

Ternary alloys containing cobalt, molybdenum, and tungsten have also been electrodeposited from the citrate type of plating bath.[31] A satisfactory bath is composed of: 0.23 mol/liter of cobalt sulfate, a total of 0.23 mol/liter of sodium tungstate and sodium molybdate (W:Mo mol ratio of 7:3), and 0.31 mol/liter of citric acid. When this solution was adjusted to pH 4 and maintained at 25°C., electrolysis at 5 amp./dm.^{2} gave a cathode deposit containing 66% cobalt ,21% molybdenum, and 13% tungsten with a cathode current efficiency of about 70%. This alloy, deposited on a low carbon steel rod, was easily scratched with a file and seemed softer than electrodeposited binary tungsten alloys. It was also found that the following ternary alloys could be electrodeposited from the citrate bath: Fe-W-Mo, Ni-W-Mo, Co-Ni-W, Fe-Co-W, Fe-Ni-W, Co-Ni-Mo, Fe-Co-Mo, Fe-Ni-Mo, and Fe-Co-Ni. This exploratory work with various ternary alloys has not been extended, at least not in this laboratory.

It is somewhat difficult to give an evaluation of the potential uses and possible applications of electrodeposited tungsten alloys. This writer knows of only two rather limited commercial applications of these alloys. Tungsten-nickel alloys have been used as a protective coating for rollers used in the film manufacturing industry and tungsten-cobalt alloys have had some special applications in the petroleum industry. It is understood that both applications made use of the wear and corrosion resistance properties of the alloys.

Experimental work carried out at the Bureau of Standards[27] resulted in a fairly complete report on the physical and chemical properties of electrodeposited tungsten alloys. The report covers such properties as: microstructure, crystal structure, hardness, hot-hardness (of cobalt- tungsten only), ductility, thermal properties (of cobalt-tungsten only), coefficient of thermal expansion (of cobalt-tungsten only), density (of cobalt-tungsten and nickel tungsten), and magnetic properties. It was also reported that thin cobalt-tungsten alloy coatings were particularly resistance to the salt spray test. It was concluded that: "*The tungsten alloys should find applications where hardness, particularly at elevated temperatures, is required. They may be competitive with chromium and hard nickel for building up worn parts or for use in dies. The good throwing power of these alkaline plating solutions should make the plating of many objects with tungsten alloy much simpler than with chromium, as complicated anodes would not be required. Suggested fields of application are on bearings, tools, pistons, cylinders, and dies.*"

Manganese, Technetium, and Rhenium (Group VIIb)

Rhenium is the only metal of group VIIb which will be included in this review. Manganese is not considered an uncommon metal and, as yet, not much has been published about the electrochemistry of technetium (a name meaning "artificial") which was first prepared in 1937 by bombarding molybdenum in the cyclotron. Probably the most satisfactory bath so far reported for electroplating rhenium is the sulfuric acid bath of Fink and Deren.[32] When this bath contains 10 g./l. of $KReO_4$ and H_2SO_4 to a pH of about one, it yields on electrolysis, bright metallic cathode deposits and, at 8 amp./dm.^{2} and a bath temperature of 70°C., the cathode current efficiency is about 15%.

The electrodeposition of rhenium-nickel, rhenium-cobalt and rhenium-iron alloys from an aqueous ammoniacal citrate bath has been reported from this laboratory.[33] A typical rhenium-nickel bath is composed of: 56 g./l. of $NiSO_4 \cdot 6H_2O$, 10 g./l. of $KReO_4$, 66 g./l. of citric acid, and NH_4OH to pH about 8. The performance of this bath in terms of percentage of rhenium in the cathode deposit and cathode current efficiency (C.C.E.) at several temperatures is given in Table XII. It should be noted that current efficiency increases with an increase of bath temperature to a maximum of about 80% at 90°C., and that the percentage of rhenium in the alloy deposit increases with increase in temperature to a maximum of 76% at 90°C.

A satisfactory rhenium-cobalt bath is composed of: 60 g./l. of $CoSO_4 \cdot 7H_2O$, 10 g./l. of $KReO_4$, 66 g./l. of citric acid, and NH_4OH to pH about 8. The performance of this bath at several temperatures is given in

TABLE XII. ***Effect of Bath Temperature in Rhenium-Nickel Bath on Cathode Current Efficiency (C.C.E.) and Alloy Composition; pH 7.5; 8 amp./dm.²***

Bath Temp. °C.	Time, Min.	Deposit Wt., g.	Analysis % Re	Analysis % Ni	C.C.E. %	Deposit Appearance
26	5	0.0879	42.3	55.5	66	Bright
45	5	0.0959	53.0	46.4	70	Edges dull
70	4	0.0829	69.6	29.8	77	Bright
90	5	0.1077	76.0	24.4	80	Edges dull

TABLE XIII. ***Effect of Bath Temperature in Rhenium-Cobalt Bath on Current Efficiency and Alloy Composition; pH 7.5; 8 amp./dm.²***

Bath Temp. °C.	Time, Min.	Deposit Wt., g.	Analysis % Re	Analysis % Co	C.C.E. %	Deposit Appearance
26	5	0.0642	81.0	20.2	50	Edges dull
45	5	0.0770	81.3	18.7	55	Bright
70	6	0.1106	82.0	18.3	75	Bright
90	5	0.1113	75.3	31.4	82	Frosty

Table XIII. It should be noted that the percentage of rhenium in the deposit reaches a maximum of 82% at about 70°C. and then decreases.

A typical rhenium-iron bath is composed of: 60 g./l. of $FeSO_4 \cdot 7H_2O$, 10 g./l. of $KReO_4$, 66 g./l. of citric acid and NH_4OH to pH about 8. The effect of cathode current density on this bath is given in Table XIV. It can be seen that the percentage of rhenium in the deposit decreases somewhat with increasing current density, whereas current efficiency is not greatly effected by current density increases. All the rhenium-iron deposits were quite bright.

TABLE XIV

Effect of Cathode Current Density (C.C.D.) in Rhenium-Iron Bath on Current Efficiency and Alloy Composition; pH 7.5; Temp. 70°C.

C.C.D. Amp./dm.²	Time, Min.	Deposit Wt., g.	Analysis % Re	Analysis % Ni	C.C.E. %
2	20	0.0492	73.0	25.6	39
4	10	0.0770	65.6	31.5	59
6	6	0.0737	61.7	32.7	65
8	4	0.0707	60.6	34.9	66
10	3	0.0625	61.3	36.0	67
12	2	0.0549	51.6	44.3	67

Adhesion of these electrodeposited rhenium alloys to copper basis metal was usually good except that some of the rhenium-cobalt alloys obtained at higher current densities had a tendency to peel away from the basis metal. Rhenium-cobalt alloys were perhaps less resistant to laboratory fumes than the other alloys. The resistance of rhenium-nickel to common reagents was perhaps somewhat better than was observed for rhenium-cobalt and rhenium-iron, although there were no very marked differences. So far as is known, no practical use has been made of these rhenium alloys.

Discussion

It may be of interest to speculate about the reasons for the lack of success in attempts to electrodeposit some of the less common transition metals and their alloys. Usually it is suggested that the activity of the metal, the hydrolysis of simple compounds, and the absence of simple metal cations in solution are among the reasons for the failures. There are, however, interesting differences within periodic table groups and periods that may be considered. For example, why is it possible to electrodeposit chromium from aqueous solution but not tungsten which is in the same group, VIb, and why is it possible to electrodeposit manganese but not titanium which is in the same period of the table? It may not be particularly significant, but these different results can be correlated with the variation in the size of the atoms of these elements. Information about the percentage cathode current efficiency of deposition of the metals of groups IVb, Vb, VIb and VIIb and the covalent radii of their atoms is summarized in Table XV. It can be seen from this table that, in each period with increasing atomic number, there is a decrease in the covalent radius of the atom and, at the same time, a tendency toward an increase in the current efficiency of metal deposition. Again, referring to Table XV, it can be seen that, for groups VIb and VIIb, with increasing atomic number and consequent increasing covalent radius the current efficiency of metal deposition decreases. Thus, it can be suggested

TABLE XV

Correlation of Approximate Cathode Current Efficiency (C.C.E.) of Deposition of Some of the Less Common Metals with Covalent Radius of Their Atoms

	IVb	Vb	VIb	VIIb
C.C.E. %	$_{23}$Ti 0	$_{24}$V 0	$_{25}$Cr 15	$_{26}$Mn 75
Radius, Å	1.324	1.224	1.172	1.168
C.C.E. %	$_{40}$Zr 0	$_{41}$Nb 0	$_{42}$Mo 1?	$_{43}$Tc 50?
Radius, Å	1.454	1.342	1.291	—
C.C.E. %	$_{72}$Hf 0	$_{73}$Ta 0	$_{74}$W 0	$_{75}$Re 15
Radius, Å	1.442	1.343	1.299	1.278

that cathode current efficiency of metal deposition tends to increase as the size of the atom being deposited decreases since, within groups as well as periods, the smallest atom may be said to be deposited with the greatest efficiency.

Since a citrate type of plating solution has been used for the electrodeposition of alloys of the three metals tungsten, molybdenum, and rhenium with the same metals, nickel, cobalt, and iron, it is perhaps of some interest to compare the approximate current efficiency of the deposition of the single metals with the efficiency of alloy deposition. Such a comparison is given in Table XVI. Whether the observation is significant or not it is to be noted that the efficiency of alloy deposition is in each case much greater than the efficiency of single metal deposition.

TABLE XVI

Comparison of Cathode Current Efficiency (C.C.E.) of Tungsten, Molybdenum, and Rhenium Plating with Efficiency of Alloys of These Metals with Iron, Nickel or Cobalt

	Tungsten	*Molybdenum*	*Rhenium*
C.C.E., *metal* deposition	less than 1%	about 1%	about 15%
C.C.E., *alloy* deposition	about 75%	about 75%	about 90%

The question of why it is possible to electrodeposit alloys of tungsten and of molybdenum and not the single metals in appreciable amounts is, as yet, unanswered. It would seem that the codepositing metal iron, nickel, or cobalt must have a marked effect on the process which is taking place at the cathode. The electrodeposit as tungsten-cobalt and tungsten-iron alloys appear to have a laminar structure[27] and this fact suggests that the cathode deposit may not be a true alloy but may instead be made up of a series of very thin layers of the two metals being deposited. A catalytic reduction theory to explain this reduction process has been proposed.[34] If this theory is used to explain the electrodeposition of tungsten-nickel alloys, the first process taking place at the cathode is the deposition of metallic nickel according to equation *A*

$$(A) \quad Ni^{++} + 2e \rightarrow Ni$$

The thin layer of nickel deposited on the cathode surface then acts as a catalyst for the reduction of tungstate anion according to equation *B*

$$(B) \quad WO_4^{=} + 8H^{+} + 6e \xrightarrow{(Ni)} W + 4H_2O$$

Then, the nickel catalyst is covered with a thin layer of tungsten, reaction *B* stops the reaction *A* then proceeds to give a new catalyst surface. This is again followed by reaction *B* and, thus, alternate layers of nickel and tungsten are deposited on the cathode surface.

Other explanations have been proposed for the mechanism of alloy deposition[35] but it is doubtful that, as yet, a completely satisfactory explanation has been offered. There is need for extensive research on various cathode processes which result in the deposition of single metals and of alloys. It is hoped that a study of cathode potentials during alloy deposition, which is now in progress in this laboratory, will give valuable information about the mechanism of deposition of alloys of tungsten and of molybdenum. Perhaps, when more is known about cathode reactions during metal deposition, a way will be found to electrodeposit some of the transition metals mentioned in this review which have not, as yet, been successfully electrodeposited from aqueous solution.

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Surface Treatment and Finishing of Light Metals

Part XI. Properties of Anodic Coatings

By S. Wernick, Ph.D., M.Sc., F.R.I.C., F.I.M. and R. Pinner, B.Sc.

AS discussed previously, the properties of the coatings obtained by the various anodizing processes may vary considerably, and depending on the specific application for which the work is to be treated, it is often possible by varying the solution, the operating conditions, the after treatment, or even the composition of the basis metal or alloy, to obtain improvement in the properties aimed at. This chapter is a general discussion of the physical and chemical properties of anodic coatings together with some of the testing methods employed, certain of which might with advantage be incorporated in routine control and inspection in industrial practice, particularly where work is to specification.

Coating Thickness

The thickness of coatings normally produced by the different anodizing processes have been described in the previous sections. As has been seen, the increase in film thickness is not linear to the treatment time, but a maximum, or limiting film thickness may often be reached when an equilibrium is established between the rate of film growth (which at constant voltage decreases with the thickness of the film) and the rate of dissolution of the film in the electrolyte. The operating time is often critical, however, in that the metal will continue to decrease in thickness after the maximum film thickness has been obtained, while in the case of some alloys, e.g., certain aluminum-magnesium and aluminum-magnesium-zinc alloys, there may even be an actual decrease of the film thickness after the maximum is reached.

In general, the limiting thickness and the rate of film growth increase with rise in current density and pH of the solution and with greater homogeneity of the alloy, and decrease with rise in temperature, vigorous agitation and the presence of heterogeneous phases of alloying constituents which accelerate dissolution of the film in the electrolyte. The most effective method of producing thicker coatings is to use low temperatures while, for the best results, internal cooling of the anodes is required. In the case of dielectric non-porous films, which are practically insoluble in the solution, such as are produced in the boric acid electrolyte, the film thickness is limited only by the electrical resistance of the film, and film growth ceases when the breakdown voltage is equal to the voltage applied.

In most cases, anodizing first increases the dimensions of the work, which are then reduced again after reaching a maximum. In general, the film itself has a volume of approximately 4/3 that of the metal from which it is formed.

In practice it is often desirable to measure the film thickness periodically, both as a check on the solution and on the quality of the work, as the thickness of the coating influences its resistance to corrosion and wear. This is of particular importance where the work is to be dyed or where close dimensional tolerances have to be obtained together with adequate protection. It is, of course, essential where a specification is to be maintained.[1]

Determination of Coating Thickness

Numerous methods have been suggested, but no technique which is both simple and accurate has been evolved suitable for all types of coatings. Methods for determining the thickness of anodic coatings in routine inspection should not destroy the film, and at least should not affect the basis metal. For more accurate work, however, with non-transparent coatings, the film is inevitably destroyed.

A. Non-Destructive Methods

(1) Direct Microscopic Measurement[2,3]

This is an adaptation of the method for determining the thickness of mirrors, and can only be used for transparent films. A microscope is employed whose adjustment includes a micrometer device. The microscope is first focused on the surface of the coating, then on the coating-metal interface. The difference measured on the micrometer gives the optical film thickness, which must then be multiplied by the refractive index, which is 1.59 for unsealed and 1.62 for hot water-sealed films.[4] The accuracy of this method increases with the thickness of the coating, and the magnification of the microscope should be high (up to 1,000 dia.).

A modification of this technique is to immerse the article in oil, which causes a reduction in the effective refractice index. The air-film interface may be focused with greater accuracy by rubbing the surface lightly with a pencil.[3] If the surface is highly reflective, the shadow of the pencil mark is taken as the metal-coating interface, or the distance between the pencil marking and its mirror image is determined, being equivalent to twice the optical thickness.

(2) Breakdown Voltage[5,6]

The application of this method is limited, as differ-

ences occur not only between coatings produced by different methods and operating conditions and on different alloys, but also within the different layers of the coating, i.e., it will vary with the thickness of the coating. The method thus requires calibration by determining the value for each alloy treated and with each change in operating conditions. A typical graph is given in Fig. 1.

By a technique developed by Compton and Mendizza,[6] a chromium plated steel ball of ⅛ in. diameter is used as the electrode and is pressed against the surface with a load of 1,000 or 2,000 gm. Alternating current is applied and the voltage raised slowly until breakdown occurs. An accuracy of ± 10% can be obtained with d.c. coatings with an approximate value of 93 volts per 0.0001 in.

Recently, a thickness tester of this type has been made commercially available.

B. Destructive Methods[1, 4, 7]

(1) Dissolving the Coating

By this method, a coated sample of known surface area is weighed accurately and the coating is stripped in a boiling solution of either 200 g./l. chromic acid and 20 cc./l. of phosphoric acid[7] or 20 g./l. chromic acid plus 35 g./l. of phosphoric acid until constant weight is obtained (approximately 10 minutes). The specimen is re-weighed and the difference in weight, i.e., the weight of the coating, is used to calculate the thickness by the formula:

$$T = \frac{10{,}000\ W}{ad}$$

where T is the thickness in μ, W, the weight of the coating in grams, a, the surface area of the coating in sq. cm., and d, the density of the coating in g. per cc.

For this purpose, the density of the coating is taken to be 2.5. To obtain T in mils, multiply by 0.0386.

Other stripping solutions which have been suggested include bromine in methyl alcohol and a sulphuric acid solution containing antimony.

In these stripping methods, the film is destroyed but the basis metal may generally be anodized again, though this naturally applies only where the shape of the work is such that the surface area may be determined without deformation.

(2) Dissolution of the Metal

(a) An early technique was developed by Wernick.[8]

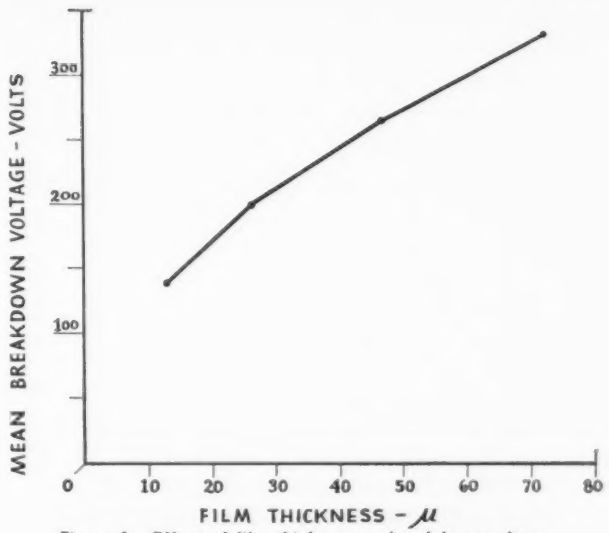

Figure 1. Effect of film thickness on breakdown voltage.

It consisted in first abrading the oxide film at a suitable point and treating this with mercury. The sample was then placed in a solution of mercuric chloride, resulting in the continuous dissolution of the aluminium. The oxide coating was thereby released in the form of small flakes which were retrieved, dried and examined.

(b) The following method was developed by W. D. Treadwell and A. Obrist[9] and is claimed to give a high degree of accuracy. A sample of sheet 1 cm. square and 0.6 mm. thick is anodized and placed on a platinum gauze approximately 1 cm. above the bottom of a small beaker. The vessel is filled half full with dried ether and is kept cold in running water; it is fitted with a tightly-fitting glass lid into which a tube is led which reaches down to about 1 cm. over the specimen and a condenser is fitted round the exit tube. Completely dry hydrochloric acid gas is led into the ether at the rate of 1 to 2 bubbles a second. The excess gas then escapes through the condenser, which holds the ether. The sheet is dissolved in 3 to 4 hours and the oxide film is taken out and washed in ether. The thickness is measured by micrometer and may, if desired, be subjected to chemical analysis or to X-ray or electron diffraction.

British Standard Requirements

A British Standard specification was issued in 1949 and a Draft Revision was issued in October, 1953. The thickness required for various applications are given in Table I.

TABLE I

Minimum Thickness of Anodic Oxide Coatings (B.S. 1615, Draft Revision 1953)

Application	*Minimum Thickness* — *Chromic acid electrolyte*		*Sulphuric or oxalic acid electrolyte*	
	in.	microns	in.	microns
Lighting reflectors for internal use	—	—	0.00020	5.1
Lighting reflectors for external use	—	—	0.00060	15
Interior decorative work	0.00010	2.5	0.00020	5.1
Coatings exposed to weather	0.00015*	3.8	0.00060	15
Coatings for subsequent painting	0.00005	1.3	0.00020	5.1

**This thickness is not obtainable on some alloys.*

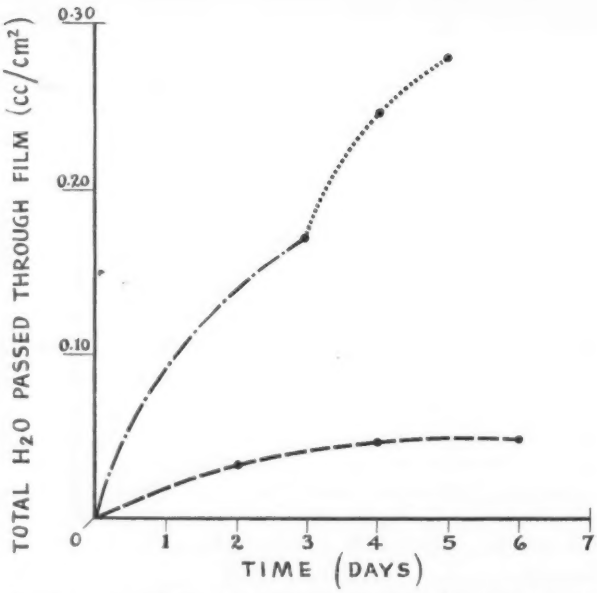

Figure 2. Permeability of chromic acid-anodized coatings. Osmosis in 0.2M sucrose at 25°C. A and B are curves for completely-oxidized Al foil remaining 76 and 22 min. respectively in the anodizing bath after electrolysis was complete.[16]

Porosity

The porosity of the coating is important in that it affects both the resistance to corrosion and abrasion and also the ease and efficiency with which coating may be dyed and sealed. It is possible to distinguish here between micro- and macro-porosity. The former is due to the dissolution of the film in the electrolyte and is a function of the operating conditions and the electrolyte used; the effect of these factors on the pore volume and pore size has been discussed earlier. Microporosity may also be influenced by the texture of the metal surfaces; thus the porosity of anodic coatings decreases with the smoothness of the surface, while it is smaller also in electropolished than in mechanically polished samples. As is to be expected, heat treatments also play their part; thus coatings on annealed work are more porous than those on quenched aluminum alloys. In these properties, anodic coatings are analagous to electrodeposits.

While micro-porosity is closely linked with the absorptive power of the coating, macro-porosity, due to faults in the basis metal or to extreme operating conditions, is detrimental both to appearance and corrosion resistance.

Fig 2 shows the permeability of chromic acid anodized coatings.

Qualitative Tests

One method for determining that sulphuric acid coatings are sufficiently microporous for dyeing was described previously. By another method, the coating is immersed in a cold aqueous solution containing:

Acetic acid	6%
Copper sulphate	0.1 to 0.5%
Zinc chloride	1.5%

The pores are shown after a few minutes by red-brown spots of copper. The larger ones appear first, while small micropores appear later. The process can be accelerated by replacing the acetic acid by 0.5% hydrochloric acid. Methods such as this measure the macroporosity only, as chemical attack does not take place through the small diameter pores.

An electrographic method which gives somewhat similar results was developed by Fischer.[11] Here, the anodized specimen, which should be perfectly flat, is covered with a filter paper impregnated with barium chloride solution and phenolphthalein. On top of the paper a copper sheet is placed and a current is passed, the aluminum being the cathode and the copper the anode. Wherever the current passes through pores in the oxide coating, the filter paper becomes colored due to the alkaline reaction products formed. In practice, however, it has been found[12] that the number of 'pores' made visible by the method increases with time, due probably to the fact that the electric current itself creates pores. Again only macropores are revealed.

Macroporosity can be determined by salt spray or other corrosion tests or, alternatively, by making the sample anodic in a solution containing 0.25% sodium alizarine sulphonate and 10% $(CH_2)_6N_4$ for 40 seconds at 13.5 volts using aluminum cathodes. If the coating is sound, no current will flow; at defective places current flows and decomposes the electrolyte causing a red deposit.

Electrophoretic Test

An electrophoretic test set for showing up macropores has recently been put on the market in Germany.[13] Called the Duffek Porosity Tester, it consists of colloidal solutions of organic dyestuffs which migrate electrophoretically to the anode under the influence of an electric current. If the anodized aluminum is made anodic, the dyestuffs are precipitated in the pores, showing up their location.

Quantitative Methods

While qualitative tests such as have been described are adequate for production control, a number of tests have been developed in the attempt to obtain quantitative results for porosity of anodic oxide coatings.

Gravimetric Methods

A number of methods have been devised which are based on impregnation of the anodic coating. One such test was described by Kubaschewski and Von Krusenstjern[12] in which the specimen is anodized, dipped for 10 minutes in distilled water in order to remove traces of electrolyte, dried at 110°C. for 30 minutes, and weighed. Subsequently the specimen is immersed for 2 hours in lead nitrate solution, again washed in distilled water, dried and re-weighed. The gain in weight caused by impregnation with lead acetate is then determined and the porosity calculated.

Reliable results can only be obtained in such methods if the anodic coating is separated from the basis metal and weighed. In a method described by Tomashov and Byalobzheskii[14] the pores are impregnated with light oil at 150°; the specimens are cooled in the oil and the excess wiped off. Subsequently the oil is extracted with acetone and weighed and the oxide film dissolved in a solution containing:

Phosphoric acid (d. 1.50)	45 g.
Chromic acid	45 g.
Water	1 l.

at 93°C. The porosity can then be calculated from the

volume of the coating and the weight of the oil absorbed.

In the case of hard anodized coatings, e.g., those produced at below 10°C. in 4N (approximately 20%/wt.) sulphuric acid, film formation is controlled by the rate of solution of the oxides in the pores rather than at the surface and the porosity can be approximately calculated simply from the thickness and the gross density of the film.

Electron Micrograph Method

An interesting method for determining microporosity was used by Keller, Hunter and Robinson[15] in their work on the mechanism of coating formation. These authors showed on theoretical grounds that each micropore formed the center of the oxide cell and confirmed this by comparing cell base patterns obtained by the electron microscope, using polystyrene impressions and silica replicas of cross sections of the anodic coating, with the pore pattern obtained under identical conditions of anodic oxidation by examining the coating itself by transmission in the electron microscope. The overall cell size can be measured directly from micrographs of the cell base pattern and a linear relation exists between cell size and forming voltage.

Assuming that the pore diameter remains constant, its value is given by the amount by which the plot of cell size against voltage is transposed from the origin.

The pore diameters of coatings obtained in phosphoric acid, oxalic acid, chromic acid and sulphuric acid were 330, 170, 240 and 120 Å respectively. The pore value can then be calculated from the relation

$$V = 78.5 \frac{p^2}{c^2}$$

where V is the pore value in %, p is the pore diameter and c the cell size.

The pore volumes obtained by this technique are lower than the true values as they do not take into account the widening of the pores by solvent action in the surface layer.

Adhesion

The adhesion of the oxide coating is normally much better than that of electrodeposits but the film tends to be weak vertically to the surface, i.e., the film is apt to crack transversely to the direction of rolling. When bent, the coating cracks in parallel lines but will not strip as electrodeposits do. Care must be taken, however, not to leave anodized work in the electrolyte when the current is switched off as this tends to loosen the film and to decrease adhesion. In general, the adhesion of the film increases with increasing temperature, acidity, and the use of d.c., as well as low current densities and longer treatment times.

Hardness and Abrasion Resistance

The oxide film itself is very hard but is too thin to increase the effective hardness of the metal itself. It will not protect the metal from strong pressure though it will resist surface scratches and thus protects the appearance and reflectivity of a polished surface.

In general, the hardness of a coating is increased by decrease in temperature of the electrolyte and in acid concentration or the use of less 'aggressive' electrolytes, by increasing the homogeneity of the alloy structure, and by increase in current density. In addition, d.c. coatings are rather harder than coatings produced by a.c.

The hardness of the film varies throughout its depth and is proportional to the porosity; thus, it is softer in the surface layers due to the solubility of the film in the electrolyte. In extremes of operating conditions, i.e., when the temperature, acid concentration, or current density are too high, the outer layers may be powdery or spongy as the solubility of the film in the electrolyte increases. This fault is therefore avoided by adjusting the operating conditions. Sealing often appreciably reduces the hardness of the coating.

The usual methods of determining hardness, i.e., Brinell, Vickers, etc., tests, are not applicable to anodic coatings as they give the hardness of the basis metal. Nor is the Rockwell scratch method or the method developed by Martens, who used a diamond point, entirely satisfactory. In these methods the object is moved horizontally against the weighted point and the hardness calculated from the width of the scratch. The results obtained are only approximate and do not take into account variations in hardness of the basis metal or variations occurring throughout the coating itself.

Various modifications of this process have been developed and interesting comparative results obtained for the different anodizing processes on the same basis metal. In this way Fischer[5] determined the abrasion resistance of the standard Eloxal coatings on an aluminum-magnesium-zinc alloy (Table II).

TABLE II. ***Hardness and Abrasion Resistance of Eloxal Coatings***[5]

Process	*Thickness (μ)*	*Hardness (Kg)**	*Abrasion resistance (double movements)*	*Hardness/thickness*	*Specific Abrasion resistance (h) (double movements/μ)*
GX	35.3	105	440,000	2.9	12,500
GXh ..	39.0	41	30,000	1.4	10,300
GS	14.7	38	85,000	2.6	5,800
WGh ..	14.7	14.5	57,000	1.0	3,900
WX ..	5.9	5.2	4,000	0.9	600

**The hardness is given in terms of kg. wt. required to make a scratch penetrating the film.*

The method developed at Siemens and Halske[17] for determining the abrasion resistance is fairly accurate in that the values obtained are almost independent of the basis metal. In this method, the work is moved to and fro under a hard metal pointer which presses on it with a constant load (300 g.). When the film is penetrated, an electric relay circuit is closed, stopping the motor operating the device. The number of double movements (H) is then taken as the abrasion resistance, though the specific abrasion resistance (h) is the better comparative value, where $h = H/\delta$, (δ is the thickness of the film in microns).

The specific abrasion resistance tends to increase with anodizing time, though here too there is a maximum value when the limiting film thickness is reached.

These authors also investigated the effect of alloying constituents on the abrasion resistance, and the values

TABLE III. ***Effect of Alloying Constituents on Abrasion Resistance of GS and GX Coatings***

GS coating : d.c. H_2SO_4, 10 to 15 volts, 1 to 2 amp. per sq. dm., 18 to 20°C., 40 min.
GX coating : d.c. $(COOH)_2$, 40 to 60 volts, 1 to 2 amp. per sq. dm., 18 to 20°C., 45 min.

	GS			GX		
Basis Metal	*Abrasion Resistance (H)*	*Thickness (μ)*	*Specific Abrasion Resist. (h)*	*Abrasion Resistance (H)*	*Thickness (μ)*	*Specific Abrasion Resist. (h)*
Al (98 to 99 per cent)	468,300	31.8	14,700	228,000	24.6	9,300
Duralumin (Al-Cu-Mg)	51,200	11.7	4,400	1,600	2.9	550
Hydronalium Hy7 (Al-Mg7)	44,000	11.7	3,800	273,300	24.6	11,600
Lautal 14 VN (Al-Cu)	1,800	11.7	150	500	3.8	130
Legal 2 (Al-Mg-Si)	133,700	14.7	9,100	149,400	16.3	9,200
Pantal (Al-Mg-Si)	191,800	14.7	13,100	72,300	8.8	8,200
KSS (Al-Mg-Mn)	179,800	14.7	12,200	223,000*	20.6	10,800
Wicromal (Al-Mn)	113,800	17.6	6,500	79,600*	20.6	3,900

**Treatment time extended to 60 minutes.*

obtained on GS and GX coatings are given in Table III.

The corresponding figures for the GXL process as well as for the a.c. processes were also determined. In general, the maximum abrasion resistance is obtained on aluminum and the Al-Mg alloys. Heavy metal-containing alloys give softer films. In most cases, the best results were obtained with d.c. sulphuric acid and oxalic acid processes, the former being best on Al, Al-Cu, Al-Cu-Mg and some of the Al-Mg-Si alloys, the latter on Al-Mg.[5] The a.c. oxalic acid process produced very soft coatings in all cases, while the WSX coatings were surprisingly abrasion resistant on Al-Mn alloy and Al-Cu.

Another method[1,18] for determining the abrasion resistance of anodic coatings consists in blasting the surface using a fine abrasive powder (silicon carbide No. 180, aluminum oxide 190) by means of compressed air under controlled constant pressure. The pressure controls the blasting velocity and is varied to suit the specific experiment. The end point of one such method[18] is when a surface of 2 cm. diameter is worn through. As in the previous method, the end point can also be given by electrical contact, a metallic spring pointer being used to close the circuit when the metal is exposed. Besides pressure and powder size, the diameter of the mouth of the blasting tube and humidity and temperature should all be controlled.

The analogous British Standards[1] method using an apparatus developed by Schuh and Kern[19] with an abrasive flow (#150 silicon carbide or aluminum oxide) of 50 to 60 g. per minute, bases its results on the weight used until visual inspection shows breakthrough of the film and formation of a black spot. This test is a measure of the internal cohesion of the coating which is a function of both its hardness and thickness. Using this method on 2S-H (commercial Al) and 53S (Al-Mg), Arlt[18] showed that, as compared to the scratch methods, little difference in the specific abrasion resistance was found with variation of coating thickness. Appreciable differences were found in the abrasion resistance of coatings sealed by various processes, the abrasion resistance in general decreasing with the degree of hydration of the anodic coating, i.e., with the efficiency of sealing.

This method has recently been used with success for the determination of abrasion resistance of hard anodized components.

In the British Standard method, the value obtained by blasting is compared with that of a standard of dimensions 3 in. × 1 in. × 18 s.w.g. which has been anodized by the Bengough-Stuart process using a 3% CrO_3 solution with steel cathodes at 40 ± 2°C. with the normal voltage cycle (0 to 40 volts during first 15 minutes, 40 volts for the next 35 minutes, 40 to 50 volts over next 5 minutes and 50 volts for a further 5 minutes). The abrasion resistance should be no less than 3.5 times that of the standard sample thus treated.[1]

Flexibility

The brittleness of a film usually varies directly with its hardness. This brittleness is manifested transverse to the direction of film growth, and coatings behave like crystals in that they are elastic within limits, though they tend to crack when bent slightly. The cracks are extremely fine, however, and unless deformation is drastic, do not appreciably affect the protective value of the coating. More elastic films are obtained by the use of higher temperatures and a.c. which for this reason are often used in the insulating of wire and strip or when anodizing must be done before plastic deformation, e.g., in the canning industry. Generally speaking, elasticity varies inversely with the hardness and abrasion resistance.

In general, the brittleness of anodic coatings is such that forming operations after anodizing must be very limited. Normally, cracks appear if the elongation reaches 0.5% and, as a result, rolling of anodized sheet cannot normally be carried out without the appearance of crazing. Great care is required in deep drawing and tool edges must be rounded and the depth of the draw restricted. However, according to Phillips,[20] continuously anodized wire may tolerate a bend of 10-15 times its thickness without visible cracking, though a certain amount of wrinkling may be noted on the underside. For electrical windings, smaller bends may be permissible as crazing will often affect the insulating properties only slightly.

The elongation was determined by Hill and Mason[21] by an extensiometer which measured the elongation at which ruptures appeared and the number of ruptures per inch. In chromic acid films, Hill and Mason found a network of lines on bending as compared with the

(*Continued on page* 64)

Analysis of Nickel in Plating Baths

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A NEW method has been developed for the quantitative determination of metallic nickel in a conventional plating bath. In every respect, this procedure compares favorably with other schemes of analysis in use today; it is a simple, direct method that is accurate as well as rapid. This new procedure shall be referred to, in this paper, as the "Sodium Cyanide-Murexide" method of analysis and it will be fully described in detail after a brief discussion of the chemical mechanisms involved.

Theory

In an aqueous medium, nickel ions combine with the purple murexide[1] dye to form a highly-colored lemon-yellow compound which is stable at a neutral or alkaline pH. This brilliant color persists, even in the presence of a large excess of ammonium hydroxide, to demonstrate a strong nickel to murexide bond.

$$Ni^{++} + \underset{\text{(purple)}}{\text{Murexide}} \rightleftharpoons \underset{\text{(yellow)}}{\text{Ni-Murexide}}$$

In the titration for nickel, there is normally an excess of nickel ions and, as long as a trace of these metal ions is still present, the murexide will remain yellow. Sodium cyanide is the preferred reagent in titrating for nickel and a small amount of murexide is the indicator. Sodium cyanide ions can easily and rapidly combine with nickel ions to form the extremely stable sodium nickel cyanide complex.[3]

(1) $2\,NaCN + Ni^{++} \rightleftharpoons Ni(CN)_2 + 2\,Na^+$

(2) $Ni(CN)_2 + 2\,NaCN \rightleftharpoons Na_2Ni(CN)_4$

(1 & 2) $4\,NaCN + Ni^{++} \rightleftharpoons Na_2Ni(CN)_4 + 2\,Na^+$

As the titration with sodium cyanide proceeds, the nickel-murexide complex is not permanently broken apart until all of the free nickel ions are used up in the formation of the nickel tetracyanide complex. At this point — called the stoichiometric point — the slightest excess of sodium cyanide will tie up all of the nickel ions that were formerly part of the murexide-nickel complex. Free murexide is liberated and the solution is now pinkish purple.

$$4\,NaCN + \underset{\text{yellow}}{Ni^{++}\text{ — murexide}} \rightleftharpoons Na_2Ni(CN)_4 + \underset{\text{pinkish-purple}}{\text{murexide}} + 2\,Na^+$$

The indicator is perfectly reversible and, if a trace of nickel is introduced to this system at the end point, the solution will become yellow again. It is of value to note that an excess of sodium cyanide, sufficient to break only one-half of the nickel murexide complex, will form an intermediate bright-orange color. This mixture of yellow and pinkish purple gives warning to the analyst of the closeness of the true endpoint. The exact procedure is given in the following.

Procedure

1. Pipette two ml. of the nickel sample into a flask and dilute this with about four hundred cc. of distilled water.
2. Add approximately ½ gram (about 1/16 teaspoon) of the specially prepared and stabilized murexide indicator, as a dry powder, to the flask and swirl the mixture a few seconds until a deep lemon-yellow color develops.
3. Titrate with the standardized sodium cyanide solution to get a distinct and sharp color change to the final pinkish-purple endpoint.

Calculations:

$$\text{Nickel Metal} = (\text{ml. sodium cyanide}) \times \frac{(0.05869)}{2} \times (\text{Norm. NaCN}) \times \frac{1000}{2} \times (0.134) = \text{Factor A in oz./gal.}$$

$$\text{Nickel Sulphate} = \text{Factor A} \times 4.478 = \text{oz./gal.}$$

$$NiSO_4 \cdot 6H_2O = \text{Factor B in oz./gal.}$$

If magnesium is present, add 25 ml. of concentrated ammonia to the sample before proceeding with Step 2 in the procedure.

REAGENTS:

1. 0.8 Molar sodium cyanide solution.
   Dissolve about 40 grams of CP sodium cyanide in distilled water to make one liter of solution.
2. Murexide Indicator (0.2% by weight).
   Mix 200 milligrams (0.2 grams) of CP murexide with 100 grams of CP sodium chloride. Grind these together using a mortar and pestle, and transfer this powder into a dry amber-colored bottle. This indicator is sufficient for about two hundred nickel determinations and is perfectly stable in the dry state.
3. Silver Nitrate 0.1 Normal.
   Weigh exactly 16.989 grams of silver nitrate and transfer to a 1 liter volumetric flask. Fill to the mark with distilled water and mix thoroughly.
4. Standard nickel solution.
   Weigh out 4.000 grams of CP nickel metal shot and transfer to a 400 ml. beaker. Add 50 ml. of water, 25 ml. of concentrated sulphuric acid and 25 ml. of concentrated nitric acid. Gently heat the beaker until the nickel is completely dissolved. Transfer the standard nickel solution to a 1 liter volumetric flask and fill to the mark when cool. A 25 ml. sample of this stock solution contains exactly 0.100 grams of nickel metal.

5. 10% Potassium iodide solution.
   Dissolve 100 grams of potassium iodide in about 900 ccs. of water.

STANDARDIZATION OF SODIUM CYANIDE:

Method I. Using nickel solution as a primary standard.

1. Pipette exactly 25 ml. of the standard nickel solution (0.1000 grams of nickel metal) into a flask and dilute with about 350 ml. of distilled water.
2. Add ammonia drop-wise until a faint blue color is evident in the solution.
3. Add approximately ½ gram of murexide powder indicator and swirl until the solution is deep yellow.
4. Titrate with the sodium cyanide, which is to be standardized, until the solution just changes to a pinkish-purple color.

Calculations:

$$\frac{\text{gram equivalent of nickel metal}}{\text{ml. of sodium cyanide}} = \frac{0.1000 \text{ g. Nickel}}{\text{total ml. of sodium cyanide}}$$

For a 2 ml. sample of nickel plating solution:

$$\text{Factor C} = \text{Nickel metal factor (oz./gal.)} = \frac{0.1000}{\text{total ml.}} \times \frac{1000}{2} \times 0.1335 = \frac{6.675}{\text{total ml. of sodium cyanide}}$$

$$\text{Factor D} = \text{Nickel sulphate factor (oz./gal.)} = (NiSO_4 \cdot 6H_2O)$$
$$\text{Factor C} \times 4.478$$

Method II. Using Standard Silver Nitrate Solution.

1. Pipette 10 ml. of the sodium cyanide reagent into a flask.
2. Add 2 ml. of a 10% aqueous potassium iodide solution.
3. Titrate with 0.1 N silver nitrate solution to a permanent opalescence.

Calculations:

$$\text{Normality Sodium Cyanide} = \frac{0.1 \times \text{ml. silver nitrate}}{10} = \frac{\text{ml. silver nitrate}}{100}$$

$$\text{Factor E} = \frac{\text{gram equivalent of nickel metal}}{\text{ml. of sodium cyanide}} = \frac{\text{ml. silver nitrate}}{100} \times \frac{0.05869}{2}$$

$$\text{Factor F} = \text{oz./gal. Nickel metal} = \text{Factor E} \times \frac{1000}{2} \times 0.134$$

or

$$\text{Factor F} = \text{Normality Sodium Cyanide} \times 8.82$$

To obtain the factor for the nickel sulphate hexahydrate ($NiSO_4 \cdot 6H_2O$) multiply Factor F by 4.478.

Comparison of Methods

The simplicity and accuracy of the sodium cyanide and murexide can be demonstrated most effectively by comparing the new procedure with the conventional sodium cyanide-silver iodide method.

TABLE I
Analytical Results

Type of Solution	*Boric Acid*	*Nickel Chloride*	*pH of Bath*	*Ammonium Chloride*	*Sodium Thiocyanate*	*Magnesium Sulphate*	*Nickel Sulphate By Old Method*	*Nickel Sulphate By Murexide Method*
Barrel	4.5	8.3	4.4	—	—	18.0	45.0	44.7*
Barrel	4.4	8.2	4.4	—	—	24.2	43.5	43.7*
Bright	5.3	5.6	4.5	—	—	—	42.5	42.3
Bright	5.4	5.8	3.0	—	—	—	42.9	42.9
Black Ni.	—	—	6.1	—	1.9	—	15.4	14.9
Bright	5.1	5.4	4.4	—	—	—	40.6	40.9
Cold Ni.	5.4	5.8	4.5	—	—	—	42.2	42.1
Cold	2.9	5.7	6.3	—	—	—	27.7	27.4
Bright	3.3	6.2	3.8	—	—	—	32.6	32.5
Bright	5.0	5.4	4.1	—	—	—	42.3	41.8
Cold Ni.	1.0	—	7.2	0.3	—	—	4.9	5.2
Cold Ni.	3.8	—	6.6	3.0	—	24.0	28.5	28.7*
Barrel	—	—	—	—	—	—	20.1	19.9*
Bright	—	—	—	—	—	—	44.4	44.4
Bright	—	—	—	—	—	—	48.9	48.3
Bright	—	—	—	—	—	—	47.0	46.5
Bright	—	—	—	—	—	—	52.0	52.4
Barrel	—	—	—	—	—	—	20.1	20.0*

*The 2 ml. samples that contained magnesium were treated with twenty-five ml. of concentrated ammonium hydroxide before the water or murexide was added. The ammonia precipitated or complexed magnesium and prevented interference.

Sodium Cyanide — Silver Iodide

1. The endpoint is too abrupt and can be easily overstepped unless the analyst is exceptionally experienced with this titration.
2. Too many reagents that are expensive in time and labor are involved. A nickel solution must be used for standardization.
3. An excess of reagent is necessary to dissolve the precipitated silver iodide; the stoichiometric point for nickel must be passed before the endpoint is seen. $2\ NaCN + AgI \rightarrow NaAg(CN)_2 + 2\ NaI$.
4. The silver iodide precipitate does not immediately dissolve at the endpoint unless the solution is very vigorously agitated for a few minutes.
5. The sodium cyanide-silver nitrate solution is not a standard stock item and must be specially ordered at extra expense and delay.
6. Four steps are involved.

Sodium Cyanide — Murexide

1. The endpoint is very sharp while an intermediate color changes warns the analyst of the imminent endpoint.
2. Only murexide indicator, sodium cyanide and the water are needed. Silver nitrate or nickel can be used for standardization.
3. The endpoint of this method occurs at the stoichiometric point.

$$4\ NaCN + NiSO_4 = Na_2Ni(CN)_4 + Na_2SO_4.$$

A 1/10 normal solution of silver nitrate can, therefore, be used to standardize the reagent.

4. An immediate color change occurs when no more nickel is available for combination with murexide.
5. All of the reagents can be purchased as standard solutions from any reliable chemical supply house.
6. If the end point is overstepped a back titration can be easily made with the 1/10 N silver nitrate.
7. Three steps are involved.

INTERPRETATION OF TABLE II:

1. Sodium cyanide reduces the nickel ion concentration to less than two parts per ten million when it liberates the free murexide.
2. No further color change is evident and the dominant absorption band is no longer shifted towards the blue when 0.4 ppm *or more* of nickel is added to 2.5 ppm of the indicator. Quantitatively speaking, one molecule of murexide (mol. wt. = 302) combines with only one nickel ion (atomic wt. = 58.69).
3. Further evidence of a simple equilibrium between the two colored forms of murexide can be presented by the establishment of an "isobestic point" for this system at a wavelength of 511 mu. The "isobestic point," by definition, is the specific wavelength at which a two color indicator has a constant absorption that is independent of the amount of either colored compound in equilibrium. The purple form of (2.5 ppm) murexide has a transmittancy of 69% at 511 mu. Although a color change is evident with the addition of increased amounts of nickel, the transmittancy of the nickel-murexide is still 69% at 511 mu. The existence of an isobestic point is usually considered[3] as a positive proof for an equilibrium between two (and only two) colored compounds of a bi-chromatic indicator.
4. The usual amount of murexide that is used is about the same as in the table above (2.5 ppm) and only about 0.4 ppm of the nickel in the sample is tied up by the murexide. Less than 0.2% of the nickel in the average bath sample is directly involved with the indicator.

TABLE II

Resultant Colors When Nickel is Added to Murexide Solution

Nickel Ions in Parts per Million (ppm) Added to 2.5 ppm Murexide	*Color of Solution*	*Wavelength of Dominant Absorption Band*
0.00	purple	550 mu
0.10	rose	510 mu
0.20	orange	490 mu
0.30	orange-yellow	475 mu
0.40	yellow	450 mu
0.80	yellow	450 mu
2.00	yellow	450 mu

TABLE III

Results in Presence of Magnesium Salts

Nickel Sulphate oz./gal.	*Magnesium Sulphate oz./gal.*	*Ml. of Sodium Cyanide Used with Murexide*
0.0	32.5	0.0
4.9	---	0.79
4.9	16.3	0.82
9.8	---	1.96
9.8	32.5	1.98
9.8	65.0	2.00
49.0	---	7.84
49.0	6.5	7.78
49.0	13.0	7.80
49.0	32.5	7.80
49.0	65.0	7.85

From the data, it is apparent that magnesium does not interfere.

Conclusion

The data from Table I reveal that the sodium cyanide-murexide method is in excellent agreement with the results from the sodium cyanide-silver iodide titrations. Large amounts of ammonia, nickel chloride, ammonium chloride, and boric acid do not interfere with the accuracy of the new procedure. The pH of the nickel bath sample does not usually have to be corrected because the usual 400 ml addition of water will raise the pH to about six or seven. Nickel bath samples containing large amounts of magnesium sulphate must be treated with a 25 ml addition of concentrated ammonia before titration with the sodium cyanide. Magnesium will be precipitated or complexed by the ammonia, and the murexide indicator is intense enough so that a filtration is not necessary. Occasionally, if the nickel content of the sample is very high, a precipitate

of nickel cyanide may come down during the titration, but a few drops of ammonia will clear up the solution so that the titration can proceed normally to the purple endpoint.

A 0.1 N silver nitrate solution is an excellent reagent for standardizing the sodium cyanide because it is simply prepared, is obtained very pure, and gives accurate results. Standardization method I. (sodium cyanide against a pure nickel solution) showed that each ml. of this particular sodium cyanide was equivalent to 0.01232 grams of nickel metal. Standardization method II (sodium cyanide against 0.1 N silver nitrate) revealed that one ml. of the same sodium cyanide solution was theoretically equivalent to 0.01231 grams of nickel metal. The two methods of standardization are in excellent agreement within 0.1%. The silver nitrate method is preferred for still another reason; most laboratories normally use the same 0.1 N silver nitrate for the analytical determination of nickel chloride in routine nickel analysis. A solution of nickel sulphate hexahydrate ($NiSO_4 \cdot 6H_2O$) can also be used as a primary standard but the results can vary with the degree of hydration of the dry salt used in making the standard solution. The nickel factor was as much as 1.2% higher than given by standardization methods I and II when $NiSO_4 \cdot 6H_2O$ was used as a primary standard.

Murexide is, in many ways, very similar to a pH indicator such as methyl orange. Both indicators are quantitatively sensitive in terms of millionths of a mol. Table II shows that murexide changes from purple to yellow at nickel ion molar concentrations from 10^{-7} to 10^{-6}. Both indicators have an isobestic point and a dominant absorption band that is dependent upon the equilibrium between two colored forms. Other divalent metals such as calcium, magnesium, and copper, also form yellow or orange complexes with murexide and the graph formed by plotting the % transmittancy of these complexes against different wavelengths gave curves that were strikingly similar in contour to the nickel-murexide curve. It is believed, that when a divalent metal combines with murexide a chelation bond is formed between the central nitrogen atom and the divalent metal ion.

There is strong evidence that the sodium-murexide method can be directly applied for the routine analysis of copper cyanide and acid copper plating baths.[4] As the experimental work is very promising, this method is being adapted to copper and a paper will be published on the results of this research in the near future. The plater may be able to use one reagent system for both copper and nickel solutions.

The author wishes to express his gratitude to *Mr. Jesse Levine*, *Mr. Marvin Rubinstein* and *Mr. Clarence Skinner* for their valuable contribution towards the preparation of this paper.

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2. Langford, K. E., Electroplating, **4**, 277 (1951).
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FINISHING LIGHT METALS

(*Continued from page* 60)

parallel lines produced on sulphuric- and oxalic acid coatings when ruptured.

N. D. Pullen[22] showed that the loss of apparent flexibility of the coating varied appreciably with increase in thickness and that the actual elongation of anodic films averages approximately 0.3 to 0.4%.

Flexibility may also be determined by bending the anodized sheet about a steel ball and measuring the angle at which the first microscopic cracks appear. M. Schenk quotes Zerbrugg who found that the elongation (Δ) varied with the thickness of the sheet (d), according to the equation:

$$\Delta = \frac{100d}{2\,(R + d/2)} \quad \text{where R = radius of bend}$$

As, however, d/2 is negligible compared with R in a curve in which the product of the length of test-piece and the radius R is constant, the elongation is numerically equal to the length of the test-piece. The test-pieces are in practice stretched over the apparatus and the elongation may be read off directly.

The elasticity of anodic oxide coatings has been measured by Tomashov, Tyukina and Blinchevskii.[23] They used a method in which 1 mm. aluminum sheet was cut up into specimens measuring 15 by 60 mm. and bent over a 7 mm. diameter former, the angle at which cracks first appeared being measured. In this way anodic coatings on commercial aluminum alloy anodized for 20 minutes in 4N (approximately 20% wt.) sulphuric acid at 9.4 amp./sq. ft., were found to have an elasticity of several degrees which increased linearly with anodizing temperature between 10° and 40°C.

Particularly flexible coatings are stated to be obtained by anodizing in 23% sulphuric acid at 5-10 volts, 35-40°C.,[24] and this process is used to anodize strip from which instrument hands are cut. By another process, anodizing in oxalic acid is followed by immersion in oxalic acid at 80°-95°C.[25]

(*To be continued next month*)

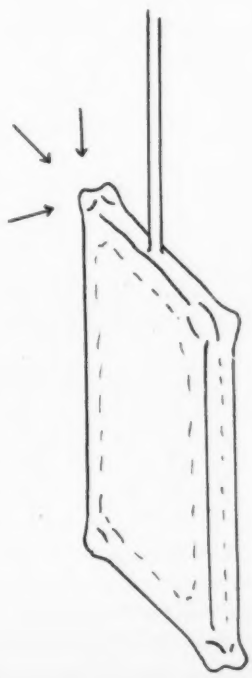
Finishing Pointers

Plating on Edges and Corners

By J. B. Mohler

WHEN plating complicated shapes it is difficult to estimate the total current required to assure the minimum required deposit in the low current density areas. The usual procedure is to allow something for loss of current to corners and edges. After a few pieces are plated, a thickness measurement is made and the current is adjusted to obtain the proper amount of metal in the time allowed for plating. For small shapes it may require double the amount of current that would be required on the basis of area alone. Offhand, it would seem that double the total current required for a perfectly uniform deposit would result in exceeding the limiting current density. It might be thought that this would be particularly true for corners and edges. The sketch shows why this does not happen.

In the sketch a heavily plated blank is shown with buildup on the corners and edges. The arrows indicate that the current has a chance to approach the corner from all directions. This allows for a concentration of current in this area. Regardless of the explanation it is a fact that the limiting current density is much higher in these areas than on the flat surfaces. Many baths are operated within 75% of the limiting current density, as determined on a flat piece, so that on such a basis only a third more current would be required at a corner to exceed the limiting current density.



The table shows measurements that were taken for deposits from various baths. Assuming a thickness of 1.0 for the center, the relative thicknesses for the edges and corners are given. It is seen that, for acid baths, the thickness is roughly 2 to 3 times greater at the edges and about 5 times at a corner. The deposit tapers off from the edges and corners, but there is a relatively heavy loss of current to within ¼ inch of the edge. As a first estimate, it could be assumed that the average current density is at least double for ¼ inch at the edge. If a 2 x 2 inch blank were plated, this would amount to almost half of the area consuming twice the current. This would mean that the total current would have to be 1.5 times to deposit the required amount of metal in the center of the blank. In other words, the average current density would be 1½ times the minimum current density.

The suggested procedure is good practice. What it amounts to is that the current is increased until the desired thickness is obtained in the desired time. It is a method of finding the total current necessary to obtain the normal operating current density in the low current density area. This can be done because of the higher limiting current density at the corners and edges.

There is a much more simple procedure to arrive at a similar result where it is impractical to estimate the current distribution. The practical procedure amounts to increasing the total current until the work starts to "burn" at the edges. Then reduce the current by about 15%. This method assumes that the limiting current density in the high current density areas can be used as a measure of the current density in the flat areas. To use such a method with reasonable accuracy would require measurement of the limiting current density of the bath by plating range test and a sufficient number of thickness measurements to establish the experience to make an intelligent guess. Such procedures are certainly justified in the absence of anything better.

Plating in a recess is a more difficult problem. Burning on the edges of the work cannot be used to estimate the current required to deposit metal in a hole. Also, the current cannot be increased until the desired thickness is obtained in the desired time. What can be done is to plate at as high a current as possible and determine the time required to obtain the desired thickness.

Ratio of Plating on Center to Edges and Corners

Bath	*Center*	*Edge*	*Corner*
Acid Copper	1.0	2.3	5.0
Lead	1.0	2.3	5.6
Nickel	1.0	2.5	5.7
Silver	1.0	1.4	1.6
Acid Tin	1.0	3.5	5.5

Science for Electroplaters

17. Rectifiers

By L. Serota

AN ever increasing use of rectifiers for furnishing direct current for plating purposes is becoming evident as larger and more economical units with improved controlled devices are made available. Essentially, a rectifier is a device which permits free current flow in one direction (very little resistance), but provides a high resistance (extremely low current flow) in the opposite or blocking direction.

Whereas the resistance of most conductors, whether single elements or more than one element, is not affected by the direction of the current, some conductors entailing physical or chemical combinations of elements, exhibit this characteristic of unilateral (asymmetric) conductivity. Some examples of such types are magnesium-copper sulfide; copper-copper (cuprous) oxide; selenium; germanium. Rectification occurs in the semi-conducting material or at the junction of these (barrier) layers. This so-called dry disc type rectifier, consisting of metal plates upon which a semi-conducting material has been deposited, has been found to be most satisfactory for the low-voltage applications in the plating industry. The selenium rectifier is used extensively because of its long operating life, light weight and compactness; its high rectifier efficiency and uniform performance over a wide temperature range; and its instantaneous operation and adaptability for many sizes and ratings to meet every requirement. The development of the germanium rectifier has now advanced to the stage where the following advantages, compared to other dry rectifiers, are claimed: 75 per cent less volume and weight; reduction of rectifier losses to ⅓ or less; no aging effects hence, no large expensive devices to compensate for aging; higher voltage per cell compared to a selenium plate.

Rectifying Plates

Construction of a rectifier (cell) is relatively simple. The selenium cell, for example, consists of an aluminum base plate or back plate (0.02″-0.06″) upon which a layer of crystalline selenium (0.0001″-0.005″) is deposited. Steel was replaced as a back plate because of its weight and greater corrosiveness, the latter being an especially important factor in electroplating equipment because of atmospheric conditions in the plating room. The aluminum plate is nickel plated to permit intimate contact with the selenium and to prevent the formation of a barrier layer between the materials. The chemically pure selenium is contaminated with an additive, such as cerium iodide, to insure good rectifier performance, since pure selenium will not show asymmetric conductivity. The selenium may be applied by the hand coating method, whereby the evenly spread powder is heated to a temperature above the melting point of selenium, about 218°C., or the pressed-powder method, in which the selenium on the base plate is subjected to a pressure of about 1000 to 2000 pound per square inch at 125°C. for a few minutes. A third process utilizes the evaporation method, whereby selenium, heated in a vacuum at about 140°C., will vaporize and condense on the baseplate.

The surface of the selenium is next coated with an artificial barrier layer, before the counter electrode or front electrode, a low melting alloy, is applied — either by spraying or vacuum evaporation. The property of asymmetric conductivity is developed at this junction. The true function of the barrier (blocking) layer is not fully understood. The addition of the artificial layer between the selenium and counter (front) electrode serves to improve the natural non-linear junction so that the rectifier unit (cell) can operate at greater applied voltages.

The rectifying properties of the cell, which are poor at this stage, are stabilized by a treatment which ranges from 6 to 24 hours. This is accomplished by applying a relatively high rectified a-c voltage to the rectifier (cell) in the blocking (reverse) direction. The barrier layer, where rectification is believed to take place, is formed between the selenium and the counter electrode during this stage. The plates are checked after the process for forward and reverse properties, after which they are graded so that the cell assemblies (stacks) will give uniform performance. This is important since, in a parallel arrangement of cells for delivering high current, the forward properties must be similar so that each plate will carry the proper share of current. If a series arrangement of cells is intended for providing high voltage, a similarity in reverse characteristics is important. A rectifier stack assembly is shown in Fig. 70.

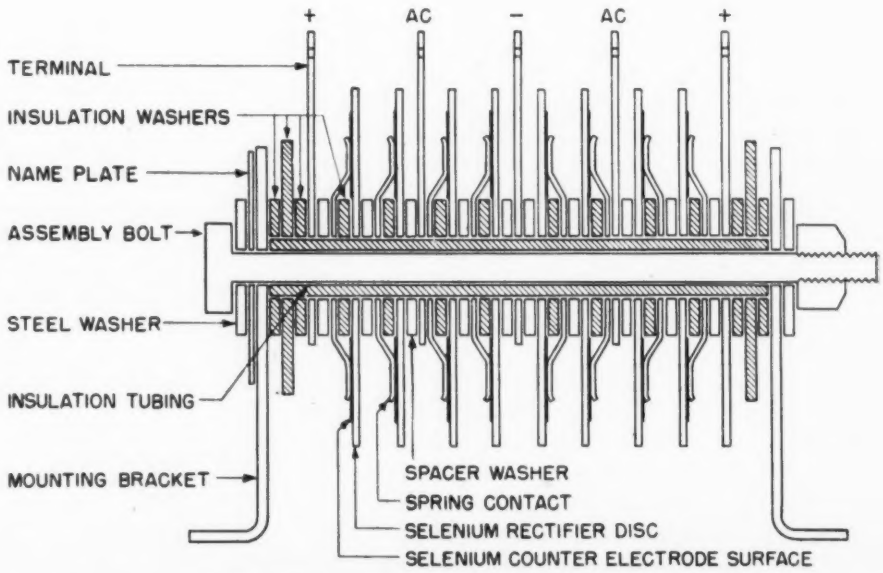


Fig. 70. Cut-away view of typical rectifier stack assembly.

Rectifier Circuits

SINGLE-PHASE HALF-WAVE:

If a single cell is connected in series with an alternating voltage, current (positive) will flow readily in one direction, that is from the base plate to the counter electrode (forward resistance), but will exhibit hardly any flow in the opposite direction (reverse resistance). Fig. 71 shows graphically such static forward and reverse current characteristics. The counter electrode side of the cell is positive and can be identified in the assembled stack as the side of the cell with the spring

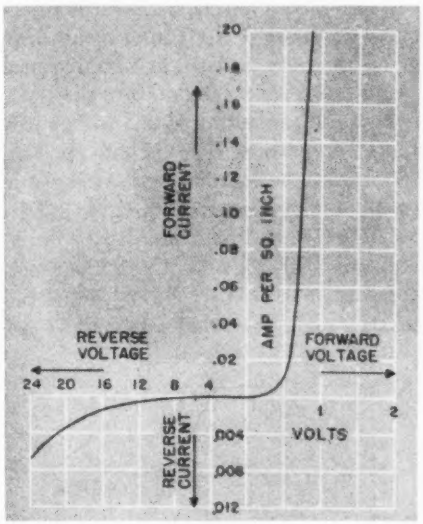


Fig. 71

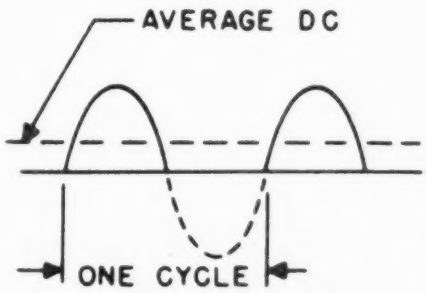


Fig. 72. Single Phase Half Wave.

contact washer. The aluminum base plate is negative. Current flow is thus said to be from the back plate to the spring-contact washer. (Electron flow will be in the reverse direction from current flow.) In such a circuit current will flow during one half of each cycle (Fig. 72). The plate in this single phase circuit performs as a half-wave rectifier and will deliver a pulsating current in one direction only. Although some simple electroplating processes may be operated with this circuit, the method is inefficient and should be limited to very small, low-cost units.

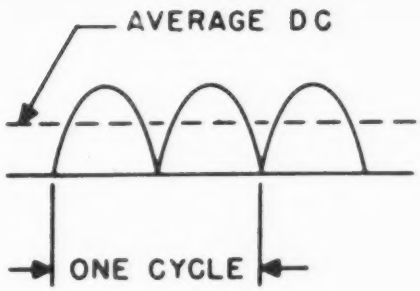


Fig. 73A. Single Phase Badge.

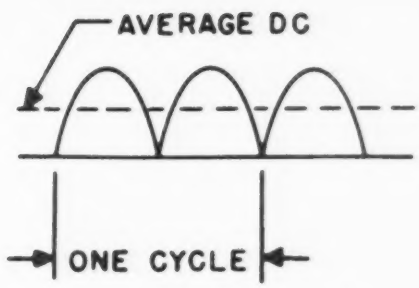


Fig. 73B. Single Phase Center Tap.

SINGLE-PHASE FULL-WAVE:

More efficient and satisfactory results may be obtained if the current is designed so that rectification occurs during each half cycle; that is a full-wave type, one which delivers both side of the alternating supply to the plating tank. Rectifiers designed for operation on single phase a-c are usually the full wave type. Two types of circuits are used to provide full-wave rectification. With one method the secondary winding of the transformer has a center tap, with a rectifier connected to each arm of this center-tapped winding. The second method, the bridge circuit, consists of four groups of plates connected in a diamond shape, with the a-c fed in at one pair of opposite corners and the d-c drawn off from the other pairs. Both circuits are represented in Fig. 73. The center tap circuit is generally used with selenium rectifier plates if not more than 6 or 7 volts are required. The bridge circuit is more economical to use when 12 volts or higher are required.

The single phase rectifiers are the simplest to build and are made in sizes up to about 1000 watts. Such units find wide use in laboratories or for single small tanks, since 110-120 volt a-c is usually available.

RIPPLE:

Possible difficulties that may arise in the use of the single phase rectifier units are associated with the fluctuations or ripples inherent in the current delivered (output) by this type of circuit. Whereas the conventional d-c ammeter or voltmeter will show a steady (average) reading, for example, 6 volts on the voltmeter, a special instrument such as a cathode ray oscilloscope will detect the fluctuations of this pulsating voltage, extending from a peak of 9.4 volts to a minimum value of zero, twice (2 ripples) per cycle or 120 times each second. Fig. 74 is a diagrammatic representation of such ripple in current from a single phase full wave rectifier.

Its relation to plating was indicated by *Louis W. Reinken* in the February 1947 issue of METAL FINISHING by reference to two plants where results obtained with a hard chromium bath in the laboratory, using a single phase rectifier, were not identical with results obtained from the same bath in the factory where current was supplied from the three-phase rectifiers or a generator. Substitution of small three-phase units in the laboratory for the single phase rectifiers gave results that were identical with those in the plant.

THREE PHASE:

When power requirements are

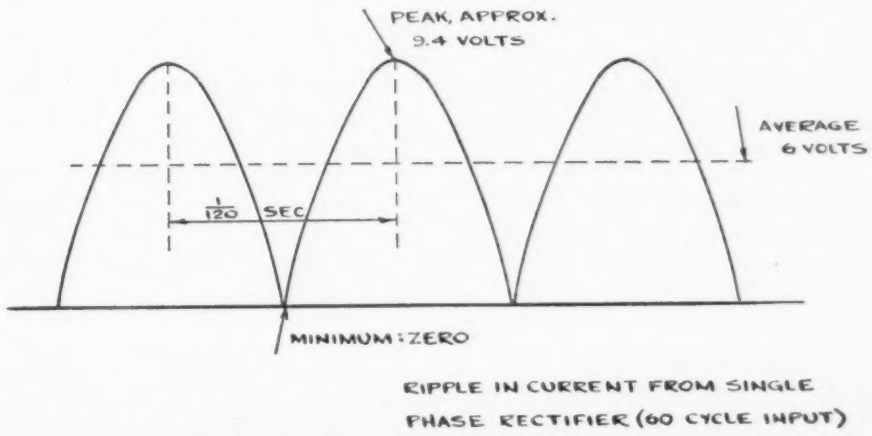


Fig. 74. Single Phase Ripple.

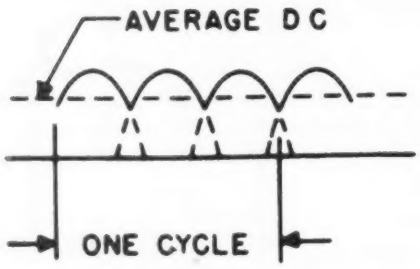


Fig. 75. Three Phase Half Wave.

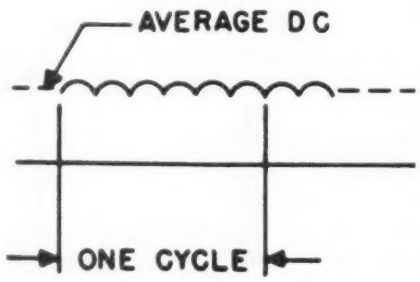


Fig. 76. Three Phase Full Wave.

greater than one kilowatt (1000 watts), plating rectifiers are generally designed for 3-phase inputs. Such units are available for all common line voltages: 220; 440; 500 volt supply. Three-phase rectifier circuits can be classified into two groups. One type, the three-phase half wave, will produce 3 ripples per cycle. Where a d-c voltmeter for such a current will read 6 volts, the rectifier will be delivering a pulsating voltage ranging from 3.6 to 7.2 volts, three times per cycle or 180 times a second, Fig. 75.

The second type, the three-phase full wave center tap (six phase rectification) or three-phase bridge will produce 6 ripples per cycle. A d-c voltmeter reading of 6 volts for this circuit will deliver a pulsating voltage with a reduced fluctuation ranging from 6.3 to 5.4 volts, 6 times per cycle or 360 times per second. Fig. 76 is the graph. For the selenium plate type rectifier, because of the higher voltage rating per plate than either the copper oxide or the magnesium-copper sulfide, the star circuit is preferred for outputs up to 6 or 8 volts. Above 8 volts the bridge circuit is preferred.

The diagrams for six common circuits operating on a rectifier unit are shown in Fig. 77. The effective value of an alternating current is called the root mean square (RMS) current. The same applies for the effective value of alternating emf.

Essential Parts

A selenium rectifier unit will consist of the following essential parts: the rectifier stack, which converts low voltage a-c to low voltage d-c; a transformer for stepping down a-c from the line to low voltage a-c, a means of regulating the output voltage (voltage control) such as tapped auto-transformers with a number of controls and 2, 3 or 6 switches, variable (sliding brush) auto-transformers or magnetic amplifiers in conjunction with the saturable iron core reactor control; d-c voltmeter and ammeter ; a ventilating system (as a fan) for circulating the air to reduce the danger of overheating; protective devices to prevent damage due to possible overload or ventilation failure. Temperature regulation is effected by a thermostatic arrangement (thermal relays) near the plates which

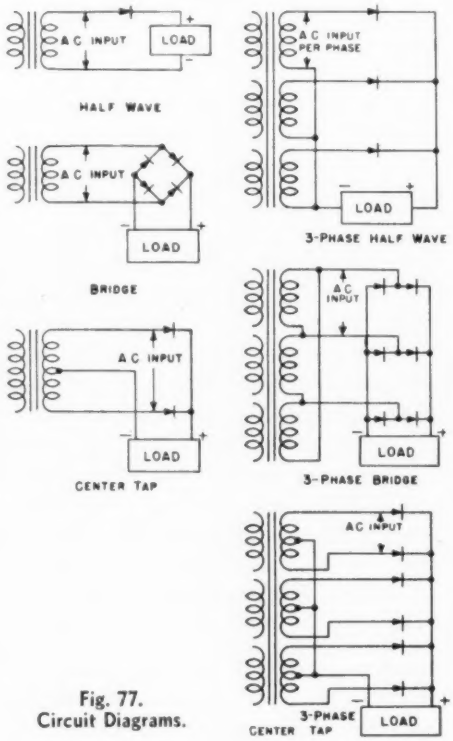


Fig. 77.
Circuit Diagrams.

may operate an automatic shutdown. Such control will, of course, include the temperature of the air entering, the cooling or ventilating system, and excessive current density which is associated with increased temperature rise. A high operating temperature is injurious to selenium rectifiers.

Because the thermal type relay (cut out) responds to the heating effect of the input curent, it indicates quite effectively the condition of the stack during the overload and will not interrupt operation of the unit unless the overload is excessively high or unduly prolonged. Stacks are rated normally on the basis of a 35°C. ambient (encompassing on all sides) temperature. Above the ambient it is necessary to reduce the d-c current of the rectifier so that a lower rms heating current will result, thus giving a lower heat rise. Higher temperatures may result in melting of the counter-electrode, which is a low melting alloy (100-160°C.). Should the counter electrode melt, the rectifier will fail. De-rating provides a safeguard for maintaining the normal temperature, and so avoids reducing the life of the rectifier; since it has been established conclusively that the final cause of failure is heat, which may be produced within the cell or induced from an external source. It is believed that the artificially formed barrier layer between the selenium surface and the counter electrode is affected by a rise in temperature. Beyond a critical temperature the layer is ruptured, resulting in a loss in rectifying properties. The graph in Fig. 78 shows the required de-rating for ambient temperatures ranging from 35°C. to 75°C. For example, the curve indicates that, for a 40°C. ambient temperature, a little over 90% of the d-c current rating is recommended (a de-

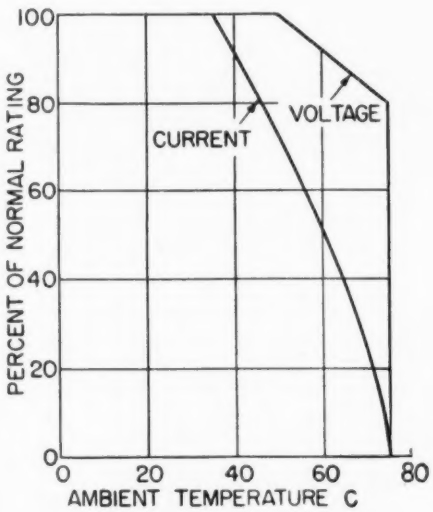


Fig. 78. Temperature derating curve.

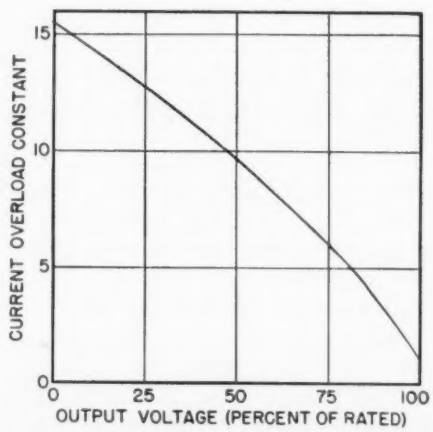


Fig. 79. Output voltage at current overload.

rating of about 10%). For ambient temperatures above 50°C. the graph indicates that a concurrent de-rating of voltage is necessary. This is due to an increase in reverse current with an increase in temperature of the rectifier. Fig. 79 represents the per cent of rated output voltage for any given current overload. Continuous operation of selenium rectifiers at a current density above that indicated in the rating will result in a shorter operating life.

Various finishes, such as several coats of paint or phenolic resin varnishes, are applied to the stacks for protection against corrosion. Continued attacks by hot acid vapors cannot, however, be checked by presently used finishes.

Aging

Changes occurring in either the forward or reverse resistance property of the selenium plate are characterized as aging. One such important change is the gradual increase in the forward resistance. An effect associated with aging is the gradual dropping off of d-c output voltage for a constant a-c input voltage. This voltage drop results in a lower efficiency and a higher temperature for a constant load current. Such factors as method of manufacture, electrical characteristics when new, operating current load, voltage, and temperature, especially above 75°C. are important in determining the degree of aging. A two year study in the aging characteristics of selenium rectifiers was reported by Brigham in the May 1953 issue of METAL FINISHING, during which period over 100 rectifiers were tested. More than 400 field test observations were made and over 500 readings recorded. Many were 1,500 ampere units rated at 12 volts; and several of 3,000, 4,000 and 5,000 units included in the test were rated at 12 volts, 9 volts and 6 volts. A graph, plotted on the basis of data collected in twenty selenium rectifiers after 14,000 hours of operation running over two years for five, six or seven days a week, 24 hours a day, shows a 10% to 12% aging characteristic. The author emphasized the severity of these tests compared to a normal plant operation. For example, a seven day week, 24 hour daily cycle corresponds to a total of 8760 hours. By comparison, in an average plant operating at one to two eight-hour shifts, the period of years of service for a selenium rectifier should be quite extensive. Fig. 80 shows the relation of aging characteristics to the current load conditions.

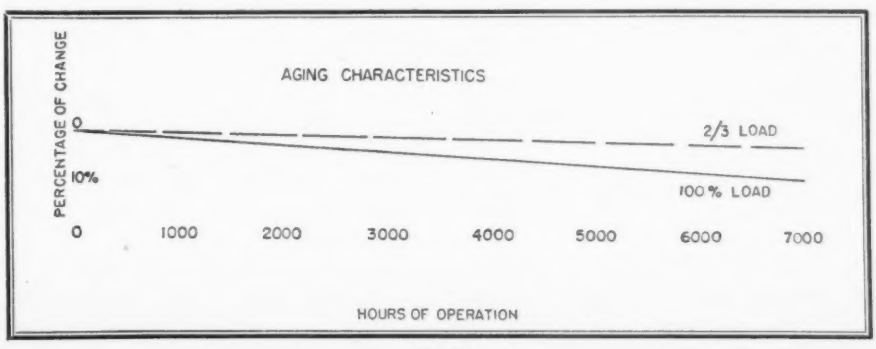


Fig. 80

Efficiency

The conversion efficiency of a selenium type rectifier based upon NEMA standards, represents the ratio (per cent) of the product of the average value of direct current output voltage and current to the total alternating current power input. Some manufacturers claim an efficiency of about 65% for a single phase, full wave selenium rectifier and an efficiency as high as 85% for three-phase circuits.

SHOP PROBLEMS

ABRASIVE METHODS SURFACE TREATMENTS CONTROL
ELECTROPLATING CLEANING PICKLING TESTING

METAL FINISHING publishes, each month, a portion of the inquiries answered as a service to subscribers. If any reader disagrees with the answers or knows of better or more information on the problem discussed, the information will be gratefully received and the sender's name will be kept confidential, if desired.

Cobalt-Tungsten Baths

Question: We have experienced on some applications where abrasion tools that were tungsten plated (flame fusion method) were more superior in abrasion resistance at room temperature than the same type tool chromium plated (electro). The subject tool is thin, intricate, and has a sorbitic structure. It does not lend itself readily for fusion plating because of martensitic transformation occurring at the surface of the base metal underneath the coating, therefore creating a distortion problem.

It is my opinion that a tungsten-cobalt deposit would prove more satisfactory for our application than a pure tungsten deposit. Since I am contemplating further development and experimentation, I would like to obtain your recommendation for technical data on electrodeposition tungsten or tungsten alloy aqueous solutions.

C. L.

Answer: No successful method has ever been disclosed for depositing pure tungsten. However, tungsten-cobalt alloys can be deposited with up to about 65% of the former metal. The citrate baths are the most common and a typical formula will be as follows:

Cobalt chloride	16.6 g./l.
Sodium tungstate	75.0 "
Citric acid	66.0 "
Ammonia	to pH 6.4-7.8

C.D.—200 amp./sq. ft.
Temp.—70 deg. C.

The above solution is claimed to deposit alloys of up to 54% tungsten at cathode efficiency of about 18% (C.N. Shen & H. P. Chung. Chinese Sci., **2,** 329 [1951]).

Other formulations will be found in the following references: M. L. Holt, R. E. Slack & P. F. Hoglund. Trans. Electrochem. Soc. **84,** (1943); W. E. Clark and M. L. Holt. J. Electrochem. Soc., **94,** 244 (1948); T. P. Hoar & I. A. Bugklow. Trans. Inst. Met. Fin., **32,** (1955).

Tantalum Plating

Question: Your METAL FINISHING GUIDEBOOK DIRECTORY, 1955 edition, does not furnish any information on Tantalum plating. If possible, please send us any formulas you may have for this type plating.

F. P. T.

Answer: No reproducible process for electrodepositing tantalum has ever been reported in the literature. However, a tungsten-tantalum alloy deposit was claimed to be possible from a bifluoride-tartrate bath in a patent granted to Armstrong & Meneffe (No. 2,160,322. May 30, 1939).

Voltage Breakdown of Anodized Aluminum

Question: We would like to obtain information regarding the voltage breakdown properties of anodized and dyed surfaces of 61 ST 6 and 11 ST 3 aluminum. In our manufacture of precision potentiometers this property is important because it is a contributing factor to the voltage breakdown of the potentiometer.

In your articles in METAL FINISHING GUIDEBOOK no mention is made of this characteristic. We would appreciate it very much if you could give us this information or advise us as to where such information is available.

V. S.

Answer: The breakdown voltage of an anodized aluminum surface will depend on the type of solution employed, the anodizing conditions, and the thickness of oxide film. Obviously, under these circumstances, there could be no standard voltage breakdown figures.

Mandeville [Engineer, **11,** 58 (1937)] gave figures ranging from 175 volts for a film thickness of 0.2 mils to 475 volts for a thickness of 1.4 mils. Campbell [(J. Electrodep. Tech. Soc., **28,** 273 (1952)] listed values for hard anodic coatings of from 250 volts for 0.001" films to over 2,000 for 0.003-4", depending on whether the film was sealed or impregnated.

Flowing Tin Plate

Question: A customer has asked for a stearate dip on an electro-tin plating job. Would you know what this is and if you do, the procedure?

M. J. H.

Answer: By stearate dip, your customer was referring to the use of a tallow pot maintained above the melting temperature of tin, and in which the electrotin is immersed in order to flow it. A number of other materials can be used instead of tallow, including palm oil and various proprietary materials.

Nickel Adhesion on Gun Parts

Question: I am having considerable trouble with my dull nickel solution peeling. I change my cleaner every two weeks and my hydrochloric acid dip every week or two, according to how much plating is done. This cleaner is about ten months old. Could it be dead? I notice a stain on the metal under the peeling. The acid is also six months old.

Has the acid lost its strength in the carboy and is not removing the oxide left on by the cleaner? I don't use any current in the cleaner but use

manual scrubbing. Could I be picking up a stain on my scrubbing bench? I have watched all these points very closely and can't figure what it is. Could it be my nickel solution? This trouble does not happen all the time. The plating seems to be bright on the high current areas.

I will appreciate any information that you can give me on this matter. These are gun parts highly polished to a mirror finish with stainless steel cutting compound.

D. R.

Answer: Packaged cleaning compounds and acids will not deteriorate on standing. Peeling may be due to low nickel solution temperature or to the high polish on the gun parts.

For best results, the parts should be acid dipped for a sufficient time to slightly etch the surface, then brushed to remove carbide smut and given a quick acid dip before plating. Good adhesion will also be obtained if the parts are given a reverse current treatment in a 25% sulfuric acid solution at 6 volts before plating.

Disintegrating Nickel Anodes

Question: We would grately appreciate receiving your opinion as to the reason for the disintegration of cast nickel anodes after 75% of the anode has been plated off.

S. S.

Answer: Since the center of a cast nickel anode cools more slowly than the skin, there is not only a larger grain size in the center but there is a tendency for any impurities in the metal to concentrate there, especially in the grain boundaries, if improper casting procedure is employed.

When the center portion of the anode is reached, the plating solution preferentially dissolves out the intercrystalline material, leaving a sponge of nickel crystals.

Cleaning Bead-Chain

Question: I'm having trouble brass plating steel bead chain in 2½ to 5 inch lengths. After soak cleaning, rinsing, and repeating, the chain is still oily when placed into the brass solution and I get unsatisfactory results. Not having an electrocleaner, I'm somewhat handicapped and would appreciate your advice on this matter.

P. L.

Answer: Your letter does not state how the bead chain is being handled. However, assuming that it is processed through the cleaning line in baskets, the probability is that the cleaning solution cannot effectively reach the center of the basket load.

This type of material should be cleaned in a rotating cylinder or, if a basket must be used, vigorous agitation should be provided so that the cleaner can circulate through the load.

Lead-Tin Alloy Baths

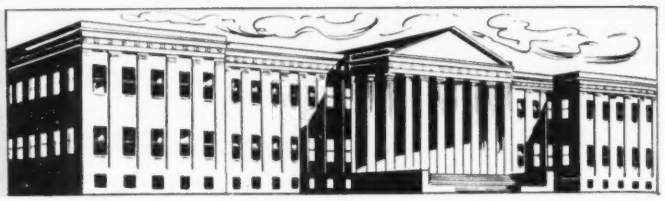
Question: We are interested in a small setup (about 100 gals.) for solder plating (60 tin/40 lead). Can you give us any information additional to that published in the METAL FINISHING GUIDEBOOK? For instance, assuming a steel tank is used, what kind of tank lining, if any, is recommended? Is a normal cleaning cycle (such as is used for other plating — nickel, for instance) plus a dilute muriatic acid dip for activation of the surface, satisfactory as a pre-plating procedure? What rinsing (or other) procedure is recommended?

F. A. L.

Answer: Rubber, Koroseal, or most plastic linings are recommended for fluoborate baths, including lead-tin. The preparatory procedure is standard. The only precaution is to avoid getting sulfate into the bath, so that a muriatic acid dip is advisable. Sulfate will precipitate lead as insoluble lead sulfate and cause roughness.

Patents

RECENTLY GRANTED PATENTS IN THE METAL FINISHING FIELD



Polishing Device

U. S. Patent 2,735,232. *Feb.* 21, 1956. *L. G. Simjian, assignor to The Reflectone Corp.*

A polishing device comprising; a mixture in a container which surrounds an object to be polished; said mixture comprising a liquid, abrasive particles, and magnetic particles; and means for applying a polyphase alternating magnetic field to the mixture for alternately varying the viscosity of the mixture and for displacing the particles in the mixture.

Immersion Tinning

U. S. Patent 2,735,788. *Feb.* 21, 1956. *F. A. Lowenheim and H. B. Forman, assignors to Metal & Thermit Corp.*

The process of forming an immersion coating of tin on the surface of materials selected from the class consisting of copper and copper base alloys which comprises contacting the surface of said materials with an aqueous alkaline solution containing dissolved tin in the stannate condition and a cyanide.

Bright Silver Plating

U. S. Patent 2,735,808. *Feb.* 21, 1956. *L. Greenspan, assignor to The American Platinum Works*

The method of electrodepositing bright silver, which comprises electrolyzing a tartrate-free solution containing silver cyanide, an alkali metal cyanide, an alkali metal carbonate, and a sufficient amount of a soluble complex of an alkali metal, antimony and a straight chain polyhydroxy aliphatic compound to impart brightness to the silver electrodeposit, said complex being formed by heating to boiling an aqueous mixture of 1 part antimony compound, 1-6 parts polyhydroxy aliphatic compound, and 1-4 parts alkali metal hydroxide until complete solution is obtained.

Bright Silver Plating

U. S. Patent 2,735,809. *Feb.* 21, 1956. *L. Greenspan, assignor to The American Platinum Works*

The method of electrodepositing bright silver which comprises electrolyzing a solution containing silver cyanide, an alkali metal cyanide, an alkali metal carbonate, and a sufficient amount of a soluble complex of an alkali metal, bismuth, and a straight chain polyhydroxy aliphatic compound to impart brightness to the silver electrodeposit, said complex being formed by heating to boiling an aqueous mixture of 1 part bismuth compound, 1-6 parts polyhydroxy aliphatic compound, and 1-4 parts alkali metal hydroxide until complete solution is obtained.

Stripping Gold

U. S. Patent 2,735,810. *Feb.* 21, 1956. *F. P. Gagliano, assignor to Secon Metals Corp.*

An electrolytic process of recovering gold from gold plated metals, which comprises subjecting the gold plated metal to electrolysis employing an electrolytic bath containing a ferrocyanide from the group consisting of alkali metal and ammonium ferrocyanide and and a cyanide from the group consisting of alkali metal and ammonium cyanides, the ratio of ferrocyanide to cyanide in the bath being within the range of from 2:1 to 5:1 by weight.

Plating Conveyor

U. S. Patent 2,736,441. *Feb.* 28, 1956. *P. A. Hauck, assignor to Hanson-Van Winkle-Munning Co.*

A processing machine, which comprises carriers for workpieces to be treated, a series of treatment stations, an elevator for lowering the carriers to and raising them from the stations, the elevator having horizontal members extending along the stations and providing supports for horizontal movement of the carriers, lifter elements on the elevator at the stations operable to raise individual carriers selectively with the elevator, a conveyor for advancing the carriers along the supports, the conveyor including a chain and means on the chain engageable with the carriers raised by the lifter elements, and means independent of the conveyor at least one station for moving individual carriers horizontally into alignment with carrier-engaging means at rest at said station during movement of the carriers with the elevator at said station.

Bright Dip for Aluminum

U. S. Patent 2,736,640. *Feb.* 28, 1956. *L. D. McGraw, assignor to Food Machinery and Chemical Corp.*

In the method of chemically polishing aluminum with a bath containing phosphoric acid and hydrogen peroxide, the improvement which comprises having present in said bath from about 1% to about 3% of graphitic carbon.

Acid Tin Bath

U. S. Patent 2,736,692. *Feb.* 28, 1956. *G. F. Eckert, assignor to E. I. du Pont de Nemours & Co.*

In a process for the electrodeposition of tin the step comprising effecting deposition from an aqueous, acidic solution of a stannous compound, said bath also containing about 0.01 to 1 gram per liter of manganous manganese as manganous nitrate.

Rust Preventive

U. S. Patent 2,736,658. *Feb.* 28, 1956. *F. W. Pfohl and V. P. Gregory, assignors to Armour & Co.*

The method of inhibiting corrosion of a ferrous metal surface, comprising forming an adsorbed protective film on said metal surface of the salt reaction product of a polyamine compound with an acid, said polyamine compound containing at least 2 amine groups in its molecular structure con-

nected by a polymethylene group having from 2 to 6 methylene groups, one of said amine groups being connected to a radical selected from the group consisting of aliphatic radicals derived from fatty acids having from 8 to 22 carbon atoms and alicyclic radicals derived from rosin acids, said acid reacted with said polyamine compound to form a salt thereof being selected from the group consisting of fatty and rosin acids containing from 6 to 22 carbon atoms.

Cyanide Waste Treatment

U. S. Patent 2,737,298. *March* 6, 1956. *F. J. Hendel, assignor to Wigton-Abbott Corp.*

The process for treating aqueous cyanide waste solution that comprises adding to the said solution the amount of alkali metal halide at least approximately equivalent to the cyanides in the solution, adjusting said solution to an alkaline pH in excess of about 8.5, and subjecting the resulting alkaline solution to electrolysis at a potential of about 5-7 volts until 2 to 6 kw. h. of energy has been consumed for each quantity of cyanide equivalent to one pound of NaCN to thereby decompose all of the cyanides originally present.

Copper Coating Aluminum

U. S. Patent 2,737,463. *March* 6, 1956. *L. M. Lawton and S. T. Ross, assignors to General Motors Corp.*

A method of applying a copper coating to a base metal having a surface composed at least preponderantly of aluminum comprising coating said base with a slurry of cuprous chloride suspended in rosin plasticized with a terphenyl type compound, thereafter heating said base and slurry therein for a time and at a temperature sufficient to volatize excess plasticizer and thereby dry the slurry on said base and then heating the base and dried coating at a higher temperature than the drying temperature and for a time sufficient to form a copper coating on said base.

Phosphating Cleaner

U. S. Patent 2,737,498. *March* 6, 1956. *H. M. F. J. Frasch, assignor to Societe de Produits Chimiques des Terres Rares*

A product useful in the preparation of metallic surfaces for coating, said product consisting essentially of an aqueous solution of at least one organic grease solvent miscible with water in all proportions in a concentration of 5-20% of said aqueous solution; and of at least one complex double acid phosphate salt of at least one ethanolamine and chromium, the amount of phosphate of said complex double acid phosphate salt being so adjusted that the pH of said aqueous solution is between 0.5-3.0.

Chromium Plated Die

U. S. Patent 2,736,670. *Feb.* 28, 1956. *E. M. Griffiths, assignor to National Glass Co., Inc.*

In a method of surface treating an extruding die formed of steel of approximately 50 Rockwell C hardness comprising the steps of coating said die with a layer of chromium of predetermined thickness, heating said coated die at approximately 2,300°F. for a period of approximately six hours to form an austenitic chrome steel layer resulting from penetration of the steel by the chromium air cooling said heated die for approximately six hours to stabilize the austenitic layer formed on the surface of said die, reheating said die at approximately 1,600°F. to obtain a fine grain of austenitic layer on the surface of said die, and cooling said die to form a surface resistant to corrosion and electrolytic action during an extruding operation.

Method for Tin Plating Bunched and Braided Wire

U. S. Patent 2,737,483. *March* 6, 1956. *F. A. Lowenheim and H. E. Hirschland, assignors to Metal & Thirmit Corp.*

Process for making tin plated bunched or braided copper wire consisting of a plurality of fine gauge constituent strands regularly intertwisted or interwoven together, which comprises immersing untinned bunched or braided wire in a potassium stannate electroplating bath, said bath containing about 0.25 to about 3.0 mols per liter of potassium stannate and about 0.15 to about 3.5 mols per liter of free potassium hydroxide, operating said bath at a cathode current density of about 30 to about 1,000 amperes per sq. ft. and a temperature of about 50° C. to substantially the boiling point of the bath, electroplating tin upon each of said strands of said wire to entirely cover each strand and until an amount of tin equal to about 1 to about 2% by weight of the wire has been plated, thereby forming a tinned bunched or braided wire in flexible condition each of whose constituent strands are plated with tin and separated from adjacently lying strands, removing the wire from the bath and rinsing and drying the same, and heating the plated wire under non-oxidizing conditions to reflow the tin plate.

Bright Nickel Plating

U. S. Patent 2,737,484. *March* 6, 1956. *F. Passal, assignor to United Chromium, Inc.*

In an aqueous acidic bath solution for bright nickel plating containing at least one nickel salt as the source of the nickel and a substituted aromatic compound as a secondary brightener in which said substituent comprises an $—SO_2$ containing moiety with the S atom linked to the aromatic moiety, the combination therewith as a primary brightener of about 0.001 to about 0.05 g./l. of a compound selected from the class consisting of 2-mercapto-benzimidazole and 2-mercapto-benzimidazole substituted by a radical having a non-metallic atom which is directly connected to the mercapto compound and which is selected from the class consisting of nitrogen and carbon.

Copper-Lead Alloy Bath

U. S. Patent 2,739,106. *March* 20, 1956. *W. G. Hespenheide and C. L. Faust, assignors to American Brake Shoe Co.*

A method of electrodepositing on an article arranged as a cathode a copper-lead alloy including the step of passing an electric current through an aqueous bath containing, as the essential ingredients for co-depositing copper and lead on said article, copper cyanide in a concentration of about 22.5 to 28 grams per liter as the source of copper for the alloy, free cyanide to suppress copper ionization, and lead pyrophosphate as the source of lead for the alloy, free cyanide to suppress copper ionization, and lead pyrophosphate as the source of lead for the alloy, said lead pyrophosphate being derived from a soluble lead salt in a concentration of about 2.7 to 3.5 grams per liter and alkali metal pyrophosphate salt in a concentration of about 100 to 120 grams per liter, said bath having a pH of about 8 to maintain lead pyrophosphate in solution.

ABSTRACTS

Operational Troubles with Nickel Plating Baths and Their Removal

O. A. Stocker, A. Korbelak and S. A. Carrano: *Nickel Berichte* (Germany). Vol. 12, No. 10, pp. 174-180.

The troubles which can occur with nickel plating processes are manifold and numerous. The possible causes of defects and their avoidance or removal serves to fill the technical literature. It is much better and more correct practice to avoid these disturbances by means of careful control than to attempt to deal with the troubles subsequently and to make good the accruing defects. Logically, bath control by an experienced technician will provide a certain assurance that disturbances will not occur which can lead to costly scrapping or to complaints.

A survey on this aspect is provided by the authors based on experience gathered from hundreds of plants and the plant disturbance troubles considered are handled generally.

Determination of Anodic Coating Thickness on Aluminum by Weight Analysis

A. Prati: *Aluminio* (Italy). Vol. 23, No. 1, pp. 7-22.

The results are given of an investigation into the accuracy of the weight-analysis method for the determination of the coating thickness of anodized aluminum. The evaluation is based on a statistical analysis of the results of a systematic number of determinations carried out on test samples, which were prepared as accurately as possible.

The Action Mechanism of Surface Reactive Substances on the Electroplating of Metals

A. I. Lewin: *Shurnal Fisitscheskoi Chimii* (Journal of Physical Chemistry —Russia). Vol. 28, No. 1, pp. 116-126.

Two series of measuresments were conducted which show the influence of additions of surface-reactive (and in part complex-forming) compounds on the potential of a copper and a zinc electrode respectively for 0.5 M copper sulfate solution and 1 M zinc sulfate solution respectively at constant temperature (without current) for varying effective times. Tables of these figures are given.

Further, the influence of surface-reactive substances was investigated on the electrode polarization (copper) in the solution 0.2 M $CuSO_4$+0.5 M $Na_4P_2O_7$ at 25°C. and in a pyrophosphate solution. Tables of the results are given in the text. A diagram shows the influence of cation-forming surface-reactive substances on the extent and character of the zinc cathode polarization. The influence of the temperature on the zinc cathode polarization is shown with the addition of tetrabutylammonium iodide and the ascertained dependency of E and i for some solutions is given in a diagram:

$$\Delta E = a + b \log. i.$$

Coppering of Stainless Steel

Metallwarenindustrie und Galvanotechnik. Vol. 45, No. 9, p. 457.

The various types of stainless steels behave in a similar manner to aluminum, being covered with a thin oxide coating which is self-healing on being damaged. This impedes the adhesion of an applied electroplated coating. The oxide skin must, accordingly, be removed and should not be allowed to form again before the application of the electrodeposit. It does not suffice merely to degrease the ware as a preliminary. The chromium must either be dissolved out, by which the stainless steel would lose its surface characteristics, or else the metal must be plated immediately after or simultaneously with the removal of the oxide skin.

The first effect is achieved by pickling in hot concentrated hydrochloric acid or acid mixtures or by anodic pickling in hydrochloric acid or cathodic treatment in about 30% sulfuric or hydrochloric acid at 4-6 volts, after which the metal is dipped for a short time in dilute hydrochloric acid and then immediately passed to the plating bath. Another process which can be used coats the metal in a reducing bath simultaneously with nickel or copper, and with repeated alternating reducing and covering until a uniform coating is achieved. It is recommended that strong acid, chloride-rich baths be used for the plating. A bath has been used with a solution of 2 g./l. copper chloride, 225 g./l. hydrochloric acid and 20 g./l. sodium chloride, in which the ware is first pickled for about 10 seconds, and then the metal is coppered in the same solution for 1 minute at 1 amp./sq. dm. with the use of graphite anodes.

Defects with Hot-Dip Galvanized Sheets

H. J. Wiester and D. Horstmann: *Metalloberflaeche*. Vol. 6, pp. B146-151.

By demonstration and discussion, some of the most important defects phenomena are shown, which are caused by the zinc bath, defective pickling, unsatisfactory heating, surface defects of the steel sheet, and defects in the sheet material. Defects with the same external appearance forms can, however, be ascribed to varying sources.

It is immaterial in the case of "tear" formation or "weeping" whether the change in the viscosity of the zinc melt, which is responsible for this trouble, is caused by the use of an oxide-containing zinc bath or whether it is caused by oxide residues on the steel sheet being galvanized and, further, whether these oxide residues have remained on the sheet steel surface because of defective pickling and rinsing treatment or whether they have been exposed by removal, during pickling, of the iron-overlapping resulting from over-rolling.

Chromium Plating of Light Alloy I. C. Engine Cylinders

Metallwarenindustrie und Galvanotechnik. Vol. 45, No. 2, p. 83-84.

Chromium plating on aluminum as operated at the Mahle K. G. concern Stuttgart, Germany on light alloy I. C. engine cylinders is described. In Europe the chemical pretreatment method for preparing the aluminum for plating is general. The oxide film must be removed before plating. With the chemical pretreatment method, several different processes are available, comprising dipping of the aluminum parts in various lyes, in hydrochloric or hydrofluoric acids and the chroming then follows immediately.

The fissured crack formation of the chromium coating does not adversely affect the adhesion of the deposit. On the contrary, it is considered that, if anything, it is an advantage as each individual chromium blocklet is firmly anchored to the base metal. Plating on

aluminum is conducted in the same bath as is used for chromium plating steel. The electrolyte contains:

250 g./l. chromic acid.

2.5 g./l. sulfuric acid.

The bath temperature is 50-60°C. and the current density to 50 amp./sq. dm. with a bath voltage of 4-8. Thanks to the high current density used, the Vickers hardness of the coating amounts to 1,000 kg./sq.mm. The thickness of the chromium coating applied amounts to 4 to 6 mils. In order to reduce the subsequent grinding and honing to a minimum, care is taken to deposit the chromium coating over the whole cylinder running area to a uniform thickness (tolerance 0.02 mm.). With the designing of cylinders for two stroke engines, care must be taken to provide well rounded corners for the inlet and exhaust channels as, otherwise at these points, on account of the concentration of the plating bath lines of force, a thickened chromium deposit of low strength would form. As a rule, chromium plating of the cylinders requires about 3 hours.

Modern Pickling Practice with Hot-Dip Galvanizing

H. Kalpers: *Beiztechnik.* Vol. 3, pp. 117-119 (1954).

In modern layouts, pickling of steel sheets or castings as a rule is conducted with agitation. There is generally used a solution of 6-8% sulfuric acid at 70-80°C. with a pickling time of 10-20 minutes. Triphosphate solutions are most usually used for the pickle-neutralization solutions. Sodium cyanide solutions are also very effective. In order to achieve a good corrosion protection, a zinc coating followed by an organic finish is applied.

Tubes must be pickled in bulk. The pickling of steel wire for galvanizing is conducted in hydrochloric acid of 10-15% strength. at 40°C. up to a maximum of 60°C. A general run of components and small articles is usually treated with a 5-12% solution of sulfuric acid. Pickling tanks are generally constructed of wood with a Monel lining. Other tank constructions also find employment. Floors are generally constructed of acid-resistant brick laid over a layer of acid-resistant asphalt or cement. In modern pickling layouts and, particularly in America at present, it is not general practice to recover the acids or the iron salts from the waste pickling liquors.

Acid-Free Chemical Pickling Process for Descaling of Stainless and Heat Resisting Steels

B. Wenderott: *Stahl und Eisen.* pp. 141-144 (Feb. 1955).

With the 10 to 30% chromium which is present in the steels, the chromium has a high absorption characteristic for oxygen and forms very stable oxides which are present mostly in the form of their spinels. As compared with the scale of non-alloy steels, these are only soluble with difficulty in mineral acids and cannot be transformed to the metallic condition by a reducing heating. The scale on hot-rolled stainless steel semi-products is particularly resistant.

Endeavors have been made with the objective of either completely by-passing chemical descaling with mineral acids or to limit the acid consumption. The most promising development has been to give the chrome steel a pretreatment in a molten salt bath with a mixture of caustic soda and saltpeter. The scale is altered in the salt bath so that the transformation product is easier and more rapidly soluble in mineral acids. The temperature of the salt bath is 400-500°C. and the treatment time 5 to 30 minutes. After the treatment in the salt bath, the semi-product is quenched in water for rapid removal of the salt residues and subsequently pickled in mineral acids for 5 to 20 minutes. Although the pickling times are shortened and the pickling bath losses are lowered, nevertheless the acid requirements are still considerable because the scale consists of up to 70-80% iron and nickel oxides which must be dissolved by the acid.

Tests have shown that the brown to black-colored transformation coatings produced in the caustic soda-saltpeter salt bath are not only easily soluble in acids, but can also be converted into the metallic condition by a reducing heating. The requirements for the degree of purity of the reducing gases used in the furnace are relatively low. This is so because, with the salt-bath treatment, not only the scale but also the metallic surface in its upper atomic layers, is dechromed. The metallic chromium reacts with the nitrate of the melts with the formation of Cr_2O_3 which is then converted into chromate and is absorbed by the bath. With the reducing heating, the transformation scale coatings are reduced, by which the metals iron and nickel which are freed and which are particularly active in the nascent condition, grow onto the metal surface and adhere. The semi-product passing out of the reducing furnace, if not mirror bright, is nevertheless mechanically clean and smooth and corresponds at least to the well pickled condition. A thin coating of iron or an iron-nickel alloy with 12-15% nickel is formed on the surface. The thickness of this coating amounts to about 1 micron.

Surface Treatment of Die Castings

G. Lieby: *Metall.* Vol. 8, pp. 463-467.

Various processes are available for the surface treatment of die castings. The choice of actual treatment given will be decided mainly by the application purpose of the die cast part. The cost of the treatment will also have a certain significance. The following points are of outstanding importance for a surface treatment: The resistance of the die casting material towards atmospheric and any special corrosion influences should be increased; The appearance of the parts should be improved; Surface hardness and wear resistance should be increased; For sales and commercial reasons, various surface effects are desirable.

There are dealt with in detail various treatments and aspects, comprising surface treatment by mechanical means, chemical surface treatment, lacquer coatings, electroplated coatings and foreign-metal coatings produced by non-electrolytic deposition methods as well as other surface treatment processes.

Electron Microscopic Investigation of the Structure of Copper Deposits from Fluoborate Baths

G. Bianchi: *Metallurgia Italiana.* Vol. 46, pp. 251-256.

Copper deposits were obtained by the electrolysis of solutions of 448 g./l. copper fluoborate at 30°C. and current densities between 0.025 and 25 amp./sq. dm. with the use of the purest copper anodes. The deposits showed a less crystalline appearing surface with increasing current density. With the medium and lower current densities, the surface of such deposits assumes a definite crystalline structure, while the structure with the higher current densities shows rounded, indefinite shapes.

Recent Developments

NEW METHODS, MATERIALS AND EQUIPMENT
FOR THE METAL FINISHING INDUSTRIES

Tumbling Compound

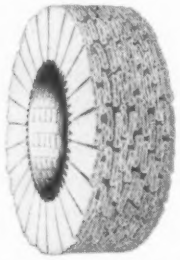
Finger Lakes Chemical Co., Dept. MF, Etna, N. Y.

Organ - Tu, a new liquid organic tumbling compound, is claimed to do away with the need of several compounds and to handle all types of work from rough deburring to precision grinding and burnishing. It functions equally well and without attack on any and all parts — steel, stainless steel, copper, brass, zinc, aluminum, silver, plastic and rubber.

It can safely be used with all types of grinding and polishing media whether synthetic or natural chips or metal shapes and is claimed to be unique in that it works first as a water conditioner, then acts to clean the media and parts and keep them clean.

Centerless Unit Sisal Buff

American Buff Co., Dept. MF, 2414 S. LaSalle St., Chicago 16, Ill.



To meet the need of metal finishing plants for an extra - flexible buff that reaches into crevices and odd - shaped contours, a new centerless unit sisal buff is now being manufactured, which is claimed to solve the problem of achieving top-speed, top-quality production on both flat and curved surfaces with a single buff. The flexible units, made of bias sisal wrapped in cloth, retain compound along leading edges and circumference to give a hard, fast cutting action that gets work done in fewer passes. This heavy-duty cutting makes buff ideal for use on brass, carbon steel, stainless steel, and aluminum.

Despite its fast cutting, the new buff is protected against heat discoloring by its patented, air-cooled centerless construction. Units are securely held in place by steel "Lok-Tite" rings, rather than solid or perforated centers. The simplified design of these rings permits an almost unlimited number of sections to be locked together with complete safety, making possible a buffing face of 12 inches or more in width.

The Centerless feature permits instant change-over to reduce costly down-time. After locking together the required number of sections by means of the metal rings, they are mounted on a telescoping hollow shaft. The complete unit thus formed can be installed or removed from the machine in a matter of seconds.

The company will arrange for a demonstration of the new buff and other centerless buffs in the user's own plant without cost or obligation.

Burnishing Compound

Apothecaries Hall Co., Dept. MF, 28 Benedict St., Waterbury, Conn.

A new burnishing compound, Ahco Burnishing Compound No. 44, is formulated for use in conventional types of tumbling equipment to produce a bright finish on steel and nickel parts. This new compound is said to provide not only the high lubricity and cushioning action required for good burnishing, but it also leaves parts clean and bright without objectionable residues. The material contains no cyanide, chromate, or similar toxic material.

Solvent Vapor Degreaser

Tect, Inc., Dept. MF, Cortland Ave. and Erie St., Dumont, N. J.

A new, safety-engineered solvent vapor degreaser is designated Model 22. This versatile unit can be operated with either Vythene, trichlorethylene, or perchlorethylene, requiring only minor adjustments of the thermostatic controls. The main body of the degreaser is constructed of galvanized steel with an outside coating of black Epodax solvent-impervious resin to reduce heat loss. A stainless steel coil is mounted as a condenser inside the chamber, and additional safety is provided by two thermostatic controls.

The lower thermostat is mounted above the stainless steel condensing coil as a safety device to prevent the solvent vapors from going out into the room in the event that the water supply fails. A red neon light shows when the machine is on.

The Model 22 requires approximately 13 gallons of solvent for operation and has a production capacity of approximately 350 lbs. of metal per hour. A wire mesh and expanded metal basket, 18" in diameter and a work rest, both galvanized, are also provided.

Model 22 is priced at only $259.00 f. o. b. Dumont, N. J. Full details on the machine are available from the manufacturer.

Chrome Sealers for Zinc Die Castings

Conversion Chemical Corp., Dept. MF, Rockville, Conn.

Two new chrome sealers for improving the appearance and protection of zinc die castings without plating are now available. According to the manufacturer, Kenvert #50 is designed to insure bright, clear finishes, excellent corrosion protection and is highly resistant to fingerprinting and staining. By varying the cycle or concentration of the solution bright iridescent or a golden brown color can be produced.

Where it is desirable to produce a greenish gray to olive drab film on zinc castings, Kenvert #51 is recommended. This protective coating can be produced in a highly stable bath which is uniformly reproducible and

STILL TANK?
FULL AUTOMATIC?

RECTIFIERS?
GENERATORS?
CONTROL EQUIPMENT?

Aluminum anodizing?

CHROMIC ACID?
SULFURIC ACID?

INSTALLATION?
ENGINEERING?

At any stage, from planning to production, your problems can *best* be solved by H-VW-M . . . the one company combining complete engineering service with a complete line of equipment, processes and supplies.

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HANSON-VAN WINKLE-MUNNING COMPANY, MATAWAN, N. J.

Plants: Matawan, N. J. • Grand Rapids, Mich.

SALES OFFICES: Anderson (Ind.) • Baltimore • Beloit (Wisc.) • Boston Bridgeport • Chicago • Cleveland • Dayton • Detroit • Grand Rapids • Los Angeles • Louisville • Matawan • Milwaukee New York • Philadelphia • Pittsburgh • Plainfield • Rochester St. Louis • San Francisco • Springfield (Mass.) • Utica Wallingford (Conn.)

1637

INDUSTRY'S WORKSHOP FOR THE FINEST IN PLATING AND POLISHING PROCESSES • EQUIPMENT • SUPPLIES

offers maximum corrosion protection. Both products are said to form good base for paint.

Barrel Finisher

Rampe Mfg. Co., Dept. MF, 14915 Woodworth Ave., Cleveland 10, O.

The above manufacturer has redesigned Model V-8 barrel finisher. The motor is now located at the rear of the machine where it is protected from water splash. The speed control handle is conveniently located at the front of the machine.

Another improvement is the use of a heavy wire mesh guard instead of a solid sheet metal guard in front of the barrels. This guard lifts up and back for easy access to the barrels.

Model V-8 has a total capacity of 8 cu. ft. available in any interchangeable combination of 2, 4, 6 or 8 cu. ft. barrels. Power is furnished by a 1½ H.P. magnetic brake motor with jogging and reverse switch. Other specifications include: variable speed drive; waterproof start-stop switch mounted in the front panel; and anti-friction bearings. Barrels can be furnished with seamless vinyl plastic lining which gives extra wear and chemical resistance.

Load-Unload Mechanism

Hanson-Van Winkle-Munning Co., Dept. MF, Matawan, N. J.

This new automatic transfer unit, operating between a metalfinishing machine and a monorail conveyor, loads and unloads work racks on the same indexing sequence as the finishing machine. The system is particularly valuable at installations where short dwell periods (short load-unload periods) prevail, since the automatic transfer unit keeps pace with the metalfinishing cycle. It automatically handles loads which are too heavy to be handled manually.

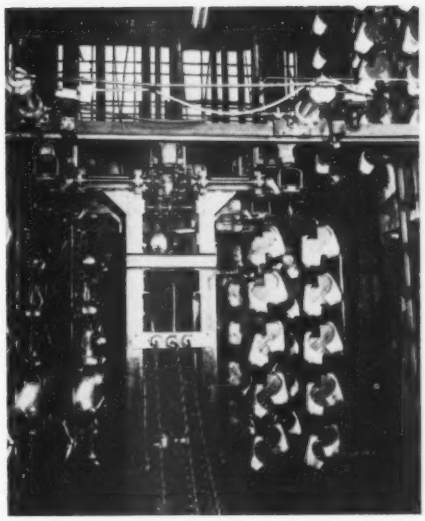
The loader is designed to shuttle on a pair of rails between the metalfinish-

ing machine and the monorail, with rails either on the floor or in an overhead position. At the top of the loader are two double stations, one for loading and one for unloading. All control mechanisms and drive units for the loader, including gear motor, electrical devices, chains and sprockets, are conveniently located for accessibility.

At installation, the loader is timed to operate in exact timing sequence with the metalfinishing machine and the monorail. The location of the loader with reference to the finishing machine can be as required, side, end, up or down position.

After completion of plating operations, the work carrier, positioned properly at unload station, signals loader to move in. Lifting cranks, one for each lane of work, then disengage the racks, parking them on the unloader. At the same time, two racks on the adjacent loader are disengaged by similar cranks and mounted in place on the adjacent empty work carrier of the plating machine.

The shuttle then moves on its tracks back to the monorail. The outer lane



deposits its rack on the monorail hook, while the inner lane rack parks in a fixed pair of saddles on the unloader framework. The unloader then retracts sufficiently to pick up the second parked rack load. At the same time the monorail moves ahead one hook spacing. This signals the unloader to move ahead a second time and deposit this second load on the monorail. Simultaneously, the loader mechanism is removing two adjacent racks from the monorail.

This system permits use of the conventional flow patterns of work loads on the monorail, with all raw stock moving into position at the plating machine, all finished stock moving away on the same empty hooks of the monorail. There is no mixing of raw and finished stock on alternate hooks of the monorail.

A unique feature of this system is the ease of synchronizing the unload-load of two plating machines, using a common monorail — where nickel plating is done on one machine and the same rack load chromium plated on another machine. It also serves where intermediate operations are performed on the monorail, such as degreasing, drying or rack stripping.

All controls for the three conveying elements — monorail, loader and metalfinishing machine — are located in a single centralized panel, so that the entire automatic operation can be properly coordinated. The above manufacturer customarily includes manual controls for all elements, enabling forward or reverse jogging into any de-

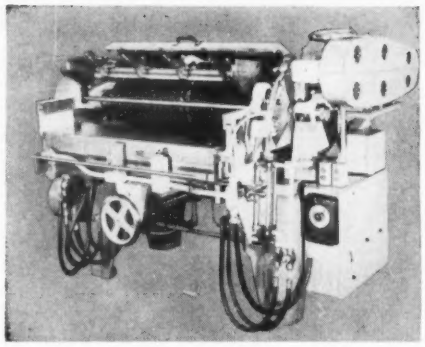
sired position. All controls are interconnected to permit restarting in cycle from any position, after stopping for any reason. Electric brakes and clutches are provided on the monorails.

Polishing Machines

Clair Mfg. Co., Inc., Dept. MF, Olean, N. Y.

New models, known as No. 302, No. 304, No. 305, and No. 308, tremendously enhance performance in use and improve the efficiency of surface finishing operations. But, of special significance is the knowledge that they reduce floor space and time study motion materially.

The motor-brackets on these new machines are entirely different from all predecessors. The castings for the motors are now rear-mounted, which removes the over-hanging motor weights from the main pivot shafts, to increase sensitivity of the buff float for improved contouring. Another desirable consequence of rigidly mounting the spindle motors at inboard rear of the new series has reduced the overall width of the machines from 9′ 4″ to 6′, an accomplishment which in no



way affects the complete interchangeability of all components with the old No. 200 series. This retention of interchangeability between the 300-series and the 200-series surface finishing machines permits a smooth work flow between the new and older models without changing set-ups or tooling.

The major modifications are such that the new designs are unequivocally identified as a completely new series of surface finishing machines which are studiously conceived to serve as co-operative team-mates with the older machines in the field. Although more versatile and efficient, the basic and exclusive features have not been altered in arriving at the new versions.

The new No. 302 model replaces the No. 202 double roll glazer and mirror polisher. The older No. 204 spoon and fork polisher, the No. 205 single spindle heeler and the No. 208 for curved handles are replaced by the new No. 304, No. 305, and No. 308 models respectively.

Alkaline Deruster

Apothecaries Hall Co., Dept. MF, 28 Benedict St., Waterbury, Conn.

A new metal cleaning compound (Ahcoloid Cleaner #210) has been developed for de-scaling or de-rusting steel and iron parts without attacking the sound base metal significantly. According to the manufacturer, the new cleaner is well suited for treating small parts in tumbling barrels.

Osmium and Tungsten Plating

Dalic Metachemical Ltd., Dept. MF, 121 Leicester Ave., Toronto 18, Can.

The above firm announces that osmium and 95% pure tungsten have been added to the list of metals which can be deposited by the Dalic process of localized plating. A complete list of metals which can be deposited by the process is available from the above manufacturer.

Flexible Polyethylene Pipe

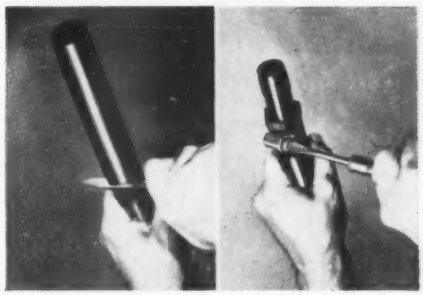
American Hard Rubber Co., Dept. MF, 93 Worth St., New York 13, N. Y.

Outstanding features of the new flexible, plastic pipe are its low cost, ease and speed of installation, and permanence. It has extremely smooth bore which reduces resistance to flow, and permits a pump to deliver a greater rate of flow at the well-head or through the distribution system.

The pipe is packaged in long coiled lengths. A 800-ft. line of ½-in. Supplex pipe, for instance, can be laid with only one fitting. This reduces installation time and eliminates loss of head encountered with the many fittings required for ordinary metal pipe systems.

The virgin polyethylene used in the pipe is highly resistant to acids, alkalis, and other corrosive chemicals and is not subject to electrolytic corrosion.

The pipe is available in sizes of ½, ¾ and 1-in. in the 75-lb. pressure-rated series, and in sizes of 1¼, 1½ and 2-in. in the standard wall series. Twin-pipe is also available in sizes of 1x1¼ in. and 1¼x1½., for jet well



installations. The pipe may be used at temperatures from 50 deg. below zero to 125 deg. above. It retains flexibility at very low temperatures, and is not damaged by freezing.

Strippable Coating

Chemical Consulting Service, Dept. MF, 3711 South Clement Ave., Milwaukee 7, Wis.

A new type of strip coating, called Strip-Kote, is used for protecting smooth and wrinkled metal finishes, enameled and lacquer finishes, highly machined precision parts, plastic, glass and chromium plated surfaces from being marred or scratched during processing, shipment and storage.

The product is a milky colored, latex-type of emulsion which is applied by brush or spray gun. The film becomes transparent, tough and flexible after it air-dries for 20 to 30 minutes. The dried film is permanently flexible and easily stripped to leave that factory-fresh appearance on protected surfaces.

The material contains no organic solvents. The coverage will vary according to the thickness of film deposited, and is 250 sq. ft. per gallon for an 0.008 inch film.

Protective Tape Applicator

Sod-Master Corp., Dept. MF, Minneapolis, Minn.

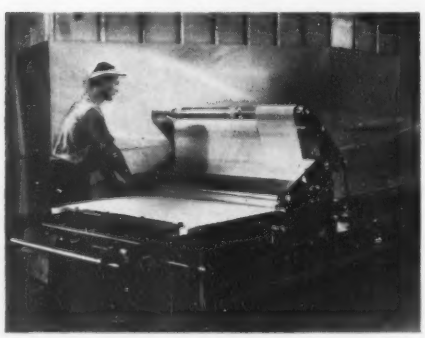
The first commercial machine designed for mechanical application of pressure sensitive tape to protect polished metal sheets, the Tape-Master protective tape applicator, reduces time required to cover 12-foot metal sheets to one minute per side.

The machine consists of two basic units, an applicator carriage which carrys, unrolls, applies and cuts the tape, and an applicator table.

Two models are presently available.

One, the Mark IV, applies protective tape in multiple widths up to four feet. The other, the Mark V, applies tape in widths up to five feet. Both models have 12-foot applicator tables.

Floor space needed for the machine is approximately 16 feet by four or five feet, depending on the model.



While the table is only 12 feet long, rails carrying the applicator carriage project two feet beyond both table ends.

The table, mounted on wheels, can be moved to any location. Floor clamps attached to the wheel mounts are lowered to prevent the table from moving during use.

One man can operate the unit, while an additional worker is required to assist in handling and stacking unwieldy metal sheets.

Price data on both models is approximate, depending on specifications supplied by users. Price of the Mark IV will run about $2,495, the Mark V about $3,175.

Drum Cradle Truck

Morse Mfg. Co., Inc., Dept. MF, 727 West Manlius St., East Syracuse, N. Y.

A retracting caster frame gives the new drum cradle truck No. 55-0 a long, wide and safe wheel base. The frame swings inside the rockers while the drum is being rocked up and loaded. It is then thrown forward by pressure on the foot lever, placing the casters well in front of the truck. A safety catch is located on the nose piece to prevent the drum from slipping while being loaded. The truck has a side opening for drums which must be dispensed into a horizontal position from the side.

The device has four large 3″ diameter wheels supported by strong cross braces to provide easy rolling to the loaded truck into dispensing position. Four 2½″ rollers mounted on top rails easily position the bungs of 55 and 110 gal. drums.

Finished in red enamel, it is also available with a shorter wheel base to accommodate 30 gal. drums.

Leather Gloves

Wearhide Glove Co., Dept. MF, Rockford, Mich.

A new line of industrial gloves features a new leather with exceptional wearing qualities. Tests by independent testing laboratories indicate that this leather, known as Horsebutt split leather, gives up to three times as much wear as other work glove leathers.

The manufacturer cites completely satisfactory results in dry cleaning tests of the gloves. In some cases this provides added savings. The gloves are extremely flexible for complete freedom of movement due to a special tanning process. This process also re-

tains the tremendous resistance to abrasian found in the natural Shell Cordovan horsehide from which the glove leather is split.

The new line of gloves, sold through industrial distributors only, includes three basic styles to meet the needs of most industrial applications. They are available in safety cuff, gauntlet and knit wrist patterns. All styles have canvas backs.

Plastic Pipe, Fittings and Valves

Vanton Pump & Equip. Corp., Dept. MF, 201 Sweetland Ave., Hillside, N. J.

Three new lines of plastic pipe, fittings and valves are available and will be marketed as three separate lines known as "P" Line "S" Line and "N" Line respectively. "P" Line (PVC) pipe and fittings offer outstanding chemical resistance, are light in weight, non-toxic and non-flammable. "S" Line (styrene-copolymer) pipe and fittings are exceptionally tough with high impact strength. These too offer broad chemical resistance. "N" Line (Buna N) pipe, fittings and valves enable the handling of many organic, as well as inorganic, solutions at elevated temperatures up to 225°F.

These products will be stocked across the nation to finally meet the complete plastic piping requirements of engineers who are seeking both high temperature and chemical resistance along with contamination-free service.

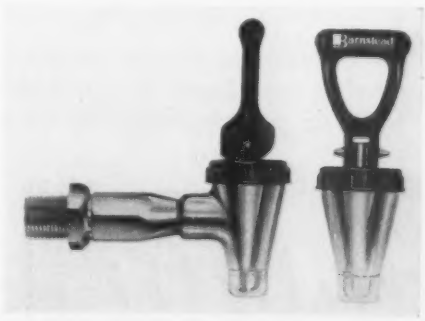
Pipe and fittings range in size from ⅛" through 6". In addition to standard globe, angle and Y valves in the "N" Line, plug cocks, straightway cocks, bib cocks, check valves, float valves and foot valves are also offered in sizes through 4". Pipe available in standard and extra heavy wall can be readily cut, sawed and threaded with conventional pipe dies.

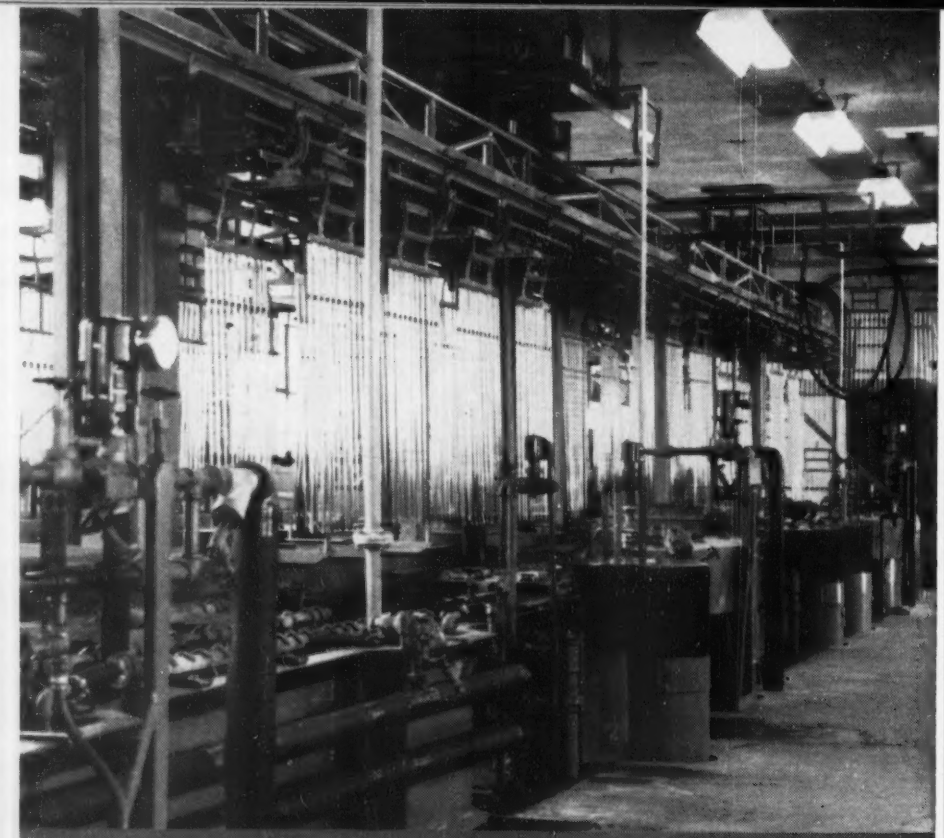
Tin-Lined Faucet for Distilled Water

Barnstead Still & Demineralizer Co., Dept. MF, 223 Lanesville Terrace, Boston 31, Mass.

A new type of tin-lined faucet for distilled water distribution systems claimed to give long trouble-free service with complete purity protection. The faucet is both self-closing type and non self-closing type depending on which way the handle is thrown. This feature eliminates the problem of leakage, binding, dripping, regrinding etc., which are encountered with distilled water taps that rely on ground joints for tightness.

The faucet is constructed of tin-lined brass with silicone plug and plastic handle. The tin lining is approximately 1/16" thick and is permanently bonded to the metal. It connects to piping by ½" male thread which makes tin-to-tin contact with any Barnstead ½" fitting. Accessory fittings for mounting the faucet on wall are available.





PLATING 2000 GOLF SHAFTS AN HOUR ON THE UDYLITE FULL AUTOMATIC

True Temper Profits with Plating Precision

Smooth operation of the Udylite Full Automatic machine has made the big difference in the nickel and chrome plating of golf shafts. The rejections due to plating defects are negligible as positive automatic action eliminated the constant hazards of hand operations.

The regulated speed of lift allows sufficient time for drainage resulting in saving some 50% of the plating solutions formerly lost—a considerable reduction in the use of nickel and chromic acid.

Plate deposit is controlled very closely—this equipment produces 2000 pieces per hour all with a fine degree of uniformity. The variable speeds of the machine itself permit True Temper to predetermine and maintain the plate deposit without changing the time or efficiency of the cleaning cycle.

These and many other unique advantages of Udylite engineering are shown in the new Full Automatic bulletin—write for your free copy.

THE Udylite CORPORATION
DETROIT 11, MICHIGAN

WORLD'S LARGEST PLATING SUPPLIER

Control of Chromic Acid Mist

Zero-Mist, the new surface-active additive for chromium plating solution control has been given enthusiastic approval by chromium platers. This new product has not only shown dollar savings to platers but has greatly improved health conditions in the plating room.

Udylite Zero-Mist is a completely stable, surface-active additive for decorative chromium plating baths which eliminates the usually troublesome mist and spray. When Zero-Mist is added, a thin curtain of foam forms at the surface of the solution which contains the mist and spray which are evident when Zero-Mist is not used.

While Udylite does not recommend elimination of proper ventilation in any chromium plating operation, there are reports of many platers using Zero-Mist successfully without washing the exhausted air. Zero-Mist has also proved to be of great benefit in plating rooms where wide tanks are difficult to ventilate, or where tanks of normal width are located near windows or doors, since it prevents the blowing of mist and spray due to the cross-currents of air.

From the dollar standpoint, Zero-Mist has shown remarkable savings to platers. Losses of chromic acid from mist and spray in the solution can amount to as much as 40%. When dragout losses are also included, tests have shown Zero-Mist to cut chromic acid waste up to 70%.

Temperatures of the chromium plating solutions have no deteriorating effect upon Zero-Mist. Additions are only required to replace the minor losses from dragout. Boiling concentrated chromic solutions do not break down or destroy its effectiveness, neither do the highest anode or cathode current densities. It is easy to maintain—very simple to control.

Zero-Mist acts by lowering the surface tension of a chromium plating solution. Because of this action, the solution runs off of the work rapidly when it is withdrawn from the tank and only a thin film remains.

The concentration of Zero-Mist for the complete suppression of mist and spray varies with the bath temperatures, especially its surface temperature. With lower temperatures, lower concentrations of Zero-Mist can be used.

A Standardized Machine for Plating

To meet the increasing demands for higher plating production and at the same time offer a plating and processing machine at lowest possible initial cost, The Udylite Corporation recently announced its new Cyclemaster. Udylite engineers say this new, completely automatic plating machine offers the greatest production of any machine built with comparable floor size.

The essential reason for its low initial cost is standardization. All Cyclemaster models have the same overall length, width and height. The only changes made are in the lengths of the various process tanks. These are changed to accommodate the desired cycles of plating, or processing and the rack size selected.

Each machine is 41 feet, 6 inches in length, of sufficient size to be ideal for cadmium and zinc plating and for copper-nickel-chrome too, where the cycle will fit into its standard length.

The new Udylite Cyclemaster is a fully automatic machine. Its operation is so simple that any regular shop man can keep it operating at full capacity. One man can handle both loading and unloading of the plated parts.

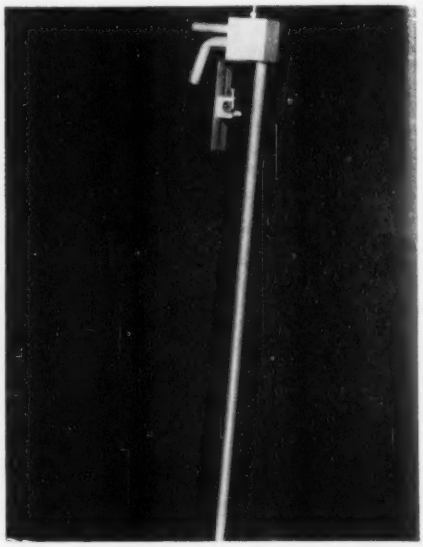
An important feature of this new machine, is a new standard multi-purpose carrier. It can be used for double spline or single spline racks. Made of special alloy metal, it has high structural strength and highest conductivity. The new carrier can also be easily adapted to inside anode plating if desired. With this carrier design the current travels only six inches from the cathode rail to the rack.

The Cyclemaster design follows many basic features incorporated in all Udylite machines. Rack spacings can be varied in individual tanks; machine is operated by hydraulic mechanism permitting variable speeds for lift, lowering or horizontal movement of racks in and out of solution; horizontal transfer of the work carriers is accomplished by a simple tee member pusher mechanism operated hydraulically.

Also, like other Udylite Fully Automatic machines the Cyclemaster is completely assembled at the factory and run in before being shipped to the customer as a complete unit.

Solution Level Control

Elkhart Controls Co., Dept. MF, Route 2, Elkhart, Ind.



A new, highly accurate, and low-cost level control for plating baths is claimed to be impervious to plating acid deterioration or build-up. Called the Eltemp level control, this simple unit efficiently maintains a constant level with no danger of mechanical or electrical failure.

The control is entirely different in appearance, materials, and design from any other level control now on the market. Its entire body is constructed of either Uscolite or a combination of Uscolite and Teflon. Utilizing their excellent chemical resistant properties and stability at high temperatures, the device has a 36-inch fill tube which adds water as needed at the bottom of the tank, maintaining the solution level within a tolerance of plus or minus three eighths of an inch. Tanks must be at least three feet deep for proper operation. The new device puts to practical use the natural law of pressure difference. A small stream of water flowing into the control automatically assures a constant level for all solutions of a specific gravity of 1.140 or heavier.

Simply and ruggedly constructed with no moving parts the unit requires no maintenance. It is guaranteed by the above manufacturer for one year.

Silicone Defoamer

Dow Corning Corp., Dept. MF, Midland, Mich.

A new faster-acting, more stable silicone defoamer, Antifoam B, is stated to be useful in a wide variety of applications, and is generally effec-

ive at concentrations in the range of 3 to 30 parts per million.

Instantly dispersible in aqueous systems, the material may be added as is without stirring or agitation. Because it has extremely small particle size, it also stays in suspension longer. Ideal for continuous processing, it will not oil out, plate out, settle or precipitate in most applications.

Remarkably resistant to heat or cold, product retains its effectiveness even after being literally frozen or boiled.

Non-Caustic Detergent

John B. Moore Corp., Dept. MF, Nutley 10, N. J.

A new safety cleaner is claimed to eliminate the hazards encountered in metal degreasing, paint stripping and cleaning of soft metals, hard metals, ceramics, wood, glassware and synthetic compounds such as rubber and plastic tiles.

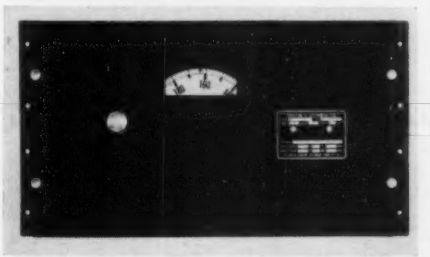
Trade-named Nocaust—NC 200, this versatile safety compound is a clean-to-handle, dustless, free-flowing powder and is 100% active. While highly alkaline, it contains no free caustic or inert material.

The above manufacturer states that the product is absolutely non-injurious to metals; wets out dirt; emulsifies; prevents redeposition of soil; deflocculates; and maintains a constant pH over a wide range of concentration.

The material is packed in economy-priced, 400 lb. lever-lock fibre drums and is stockpiled in all central shipping points in the U. S.

Electronic Potentiometer Transmits Pneumatic Signal

The Bristol Co., Dept. MF, Waterbury 20, Conn.



A new electronic potentiometer, measuring instrument equipped with a pneumatic transmitter sends a 3-15 p.s.i. signal proportional to the measured variable.

The new Dynamaster pneumatic transmitter is available in either potentiometer or bridge circuits, and will measure any variable which can be

translated into an electrical quantity. It then converts the measurement into a universal 3-15 p.s.i. pneumatic signal for transmission to a remote pneumatic indicator or recorder, or automatic controller. Thus, it is possible to present measurements such as speed, viscosity, pH, resistance, smoke density, current and voltage, frequency, and conductivity, etc., on the new miniature pneumatic receivers, along with more conventional measurements of flow, pressure, and temperature.

Standard Bristol electronic and pneumatic components are used in the new instrument. It is available either "blind" or with an indicating scale for at-the-scene measurement.

Air Blow Gun

Hydraulic Mfg. Co., Dept. MF, Kiel, Wis.

A new safety air gun, used for blowing dust or chips from work in progress, and marketed under the trade name "Guardair," is designed to protect the operator's eyes, ears and face from flying chips of metal, dust or other debris, which are blown from the area to be cleaned by the central air jet which is shot from the nozzle. A second jet of air, in the shape of a cone, is blown from the gun simultaneously with the central cleaning jet. This cone provides a protective shield or umbrella of high pressure air which prevents debris from flying upward into the operator's face, thereby reducing the hazard of injury to eyes, nose and face.

The safety gun may be used in any application where air pressure is now used for blowing work clean. Simply attach the air line to the gun handle.

Operation is by an easy grip trigger. The tool itself is also designed and balanced to handle easily with either right or left hands. The safety air gun operates with an efficient leak proof valve, which eliminates wasteful air leakage. Force of the air jets emerging from the gun is regulated by the degree of pressure placed upon the trigger.

Small Flow Control Valves

Uniflow Valve Corp., Dept. MF., 19 Quine St., Cranford, N. J.

The new Series 800 small flow control valves are precision made and designed to fill the need for control valves capable of withstanding a wide range of working pressures and temperatures. They are small in size, with overall height approximately 12″, semi steel topworks with diaphragm operators for on off or 3-15# control, air to open, or air to close, adjustable spring, Teflon packing with screwed bonnet.

Valve bodies are bar-stock with screwed ends, straight-through or angle type with removable seats and spline plug. Flow control of the valve is governed by the shape of grooves or slots milled into the plug surface. Parabolic plugs with removable seats are also available. Materials of construction for bodies and trim can be had in steel, stainless steel Type 303 or 316, brass, aluminum, Monel and many other special alloys. Body ratings to 15000 psi in steel, 5000 in stainless steel, and 800 psi in brass. Sizes: ¼″ to 1″.

Barrel Truck with Two-Wheel Safety Brakes

Valley Craft Products, Inc., Dept. MF, 750 Jefferson, Lake City, Minn.

An all aluminum barrel truck, equipped with two-wheel safety brakes, is designated Ezy-Rol Barrel Cart.

Two-wheel safety brakes incorporated in this truck are claimed to give the operator complete control of loads as heavy as 1,000 pounds when moving down ramps or steep inclines.

"Non-sparking" aluminum construction make this cart ideal for use in plants where volatile materials are present as it eliminates the possibility of sparks between the truck and steel drums being handled.

Pallet loading of drums is said to be easily accomplished with this cart while a spring actuated chime hook speeds all barrel handling operations.

Easy tipping of the heaviest barrels, it is claimed, is possible because of special design of loading shoes which allow comparatively short handles to be used. These shorter handles provide easier turning inside of truck and car bodies during loading operations.

Tubular frame of truck is ruggedly constructed from heavy aluminum pipe and has a guaranteed load capacity of 1,000 pounds. The wheels are ball bearing equipped and available in either solid rubber or pneumatic tires.

Further information may be obtained directly from the manufacturer.

I-Beam Trolley Conveyor

Chain-O-Flex Corp., Dept. MF, 3334 Lincoln Ave., Franklin Park, Ill.

This company, manufacturers of Chain-O-Flex trolley conveyors, announces a new series called T-100 for operation on either 3" I-beam or 2½" x 2¼" x ½" T-beam, for conveyor jobs under all types of conditions in ovens, spray booths, for dips, etc.

The T series features special design chain for long life and economy of operation, with strength comparable to forged chains, with an ultimate strength of 18,000 lbs. This type of chain is less expensive than forged chains, and has the economy of cable. It will not fray or become weakened by flexing, nor is it subject to twisting or stretching.

A unique 2-piece positive grip design trolley eliminates the need for load pendants. Trolley spacing 8", 12", 16" or 24" centers. Trolley capacities range from 80 to 160 lbs. and can be doubled by the use of load bars.

Trolleys are of bolted construction for ease of maintenance. Wheels are ball bearing and are grease packed at factory. The series 100 is especially practicable for operation in high temperatures up to 350°F.

Vertical curves of track can be furnished to requirements, ranging from 3½ ft. radius, up. Horizontal turns are made around traction wheels of either

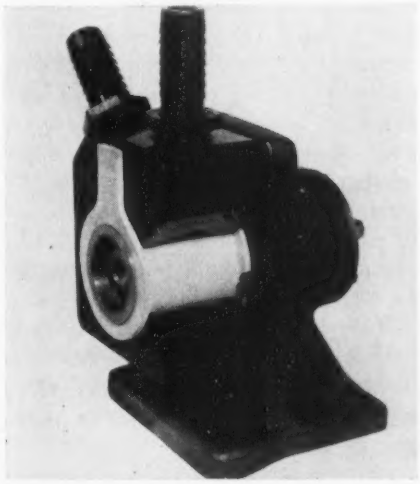
23" P.D. or 30⅝" P.D. and are available in 45°, 90° and 180° turns.

Systems up to 1,000 feet or more with chain pulls up to 2,000 lbs. can be operated with a single drive unit. Drive units are furnished to requirements. Standard drives or in-line crawler drives are available. Horsepowers range from ¼ H.P. to 3 H.P. depending on speed required or chain pull.

Liner for Plastic Pumps

Vanton Pump & Equip. Corp., Dept. MF, 201 Sweetland Ave., Hillside, N. J.

The above manufacturer announces the availability of a Kel-F elastomer liner for use with their pumps. The unusual chemical resistance of the material permits the pumping of highly corrosive products under severe conditions, which heretofore could not be handled with existing materials. The proper selection of a pump body block, along with the elastomer flexible liner, affords exceptional resistance to strong oxidizing acids, mineral acids, alkalies, aliphatic solvents, some chlorinated solvents, as well as various types of fuels and hydraulic fluids. The elastomer liner also enables the pump to handle highly corrosive red fuming nitric acid. Pumps so fitted can be operated at temperatures up to 300°F.



Cut-away view of Vanton pump showing Kel-F liner and fluid passage.

Kel-F liners are currently available, in all pumps, in capacities from ⅓ to 5 GPM.

Roof Ventilator

Detroit Blower Co., Dept. MF, 9867 Pacific Ave., Franklin Park, Ill.

Fresh air and fire fighting too highlight the story of Jet Axial, a new industrial roof ventilator. Airfoil fan blades welded to a specially designed hub insure maximum exhaust of heat, smoke, dust, and fumes at low rpms, according to the company. The new ventilator reportedly offers more working comfort for plants employees at a smaller consumption of electrical power output and a minimum of noise.

The ventilators can be furnished with a fusible link device which acts as an emergency damper opener during fires. Normally, the fusible link called a safety-vent keeps the dampers closed by spring tension when the ventilator is not in use. Exposed to intense heat, the link breaks allowing the dampers to open and smoke and heat to escape. The safety-vent device is completely independent of fan operation, according to the manufacturer. The spring itself is shielded from flames by the damper blades to prevent annealing and loss of tension from the heat.

Among the major operating features of the steel-fabricated roof exhauster are butterfly dampers that open automatically during fan operation but weather-seal the ventilator during nonuse. During fan operation, exhaust air is dissipated with sufficient velocity to exclude rain or snow and prevent exhaust re-entry, it was reported.

Eight different size roof ventilator packages are currently available. Blade diameters run from 24 to 60 inches. The varied motor outputs offer an exhaust capability range of 6640 to 53,700 cubic feet per minute.

Non-Indicating Controllers

The Wheelco Instruments Div., Barber-Colman Co., Dept. MF, Rockford, Ill.

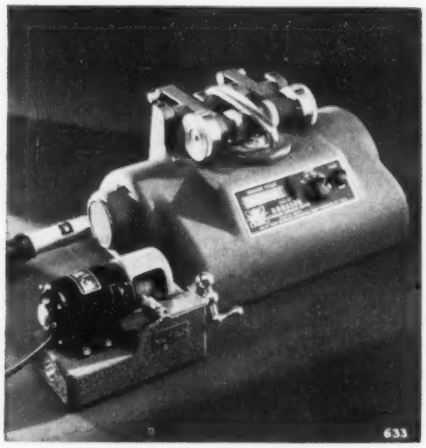
The 150 Series non-indicating controllers are potentiometer type units designed for those control applications encountered in batch process work. They employ a circuit in which the unknown voltage is connected in opposition to a known voltage with any difference used to actuate the control circuit.

The Model 151 Amplitrol is a simple on-off controller for those applications where transfer lag and dead time can be reduced to a negligible value and the simplest of control forms made usable. The Model 152 is an "anticipatory" time-proportioning controller which compensates for system inertia.

The contact rating of the new 150 Series is 6 amperes at 115 volts AC, 3 amperes at 230 volts AC. The sensitivity of the instrument is 75 microvolts for all scale spans. The fixed cycle time of the Model 152 is approximately 18 seconds.

Abrasion Tester

The Taber Instrument Corp., Dept. MF, 111 Goundry St., North Tonawanda, N. Y.



The resistance to surface abrasion of materials under cold, wet and dry conditions can quickly be evaluated accurately by the use of the new automatic model of the Abraser called Model 174.

Evaluating the resistance of surfaces to rubbing abrasion with this precision instrument is readily accomplished by means of the dual abrading wheels—unique in testing methods. These dual abrading wheels traverse a complete 360° circle on the surface to be tested, another exclusive feature necessary for accuracy relative to the weave, grain or pattern of the material.

A variety of holders are supplied for testing various surfaces.

Plastic Protective Finish

Surface Coating Engineers, Inc., Dept. MF, 2417 N. Burdick St., Kalamazoo, Mich.

A new easy-to-apply liquid plastic finish that protects metal and wood surfaces against corrosion is called Guardon. It incorporates a modified catalytic epon with other plastic resins, and handles as easily as paint in brushing, spraying, and dipping operations. It air dries in 6 hours: bakes glossy hard in 8 minutes at 350°F. No critical mixing is necessary to prepare the material for application. Two liquids are simply mixed in equal parts.

The finish forms a tough, flexible

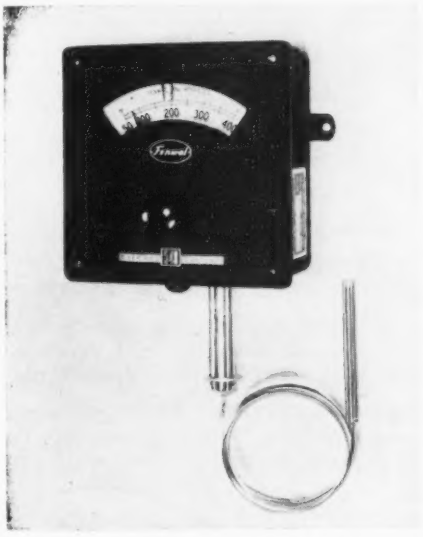
coating that resists acids, solvents, and temperatures up to 300°F. Only one coat is necessary on metal, two on wood. It bonds to any surface, new or old. Another advantage is long pot life: at least 3 days at 72°F., up to 3 weeks at lower temperatures.

The coating is available in any color as well as clear, and in hammertone, metalescent, and leatherlike finishes.

Indicating Temperature Controller

Fenwal, Inc., Dept. MF, Ashland, Mass.

A new series of indicating temperature controllers is built around interchangeable elements. The new Series 541 bulb-and-capillary controller offers high accuracy (within ±2°F. under optimum conditions), is rugged, easy to read, and is unusually convenient to adjust and service in the field.



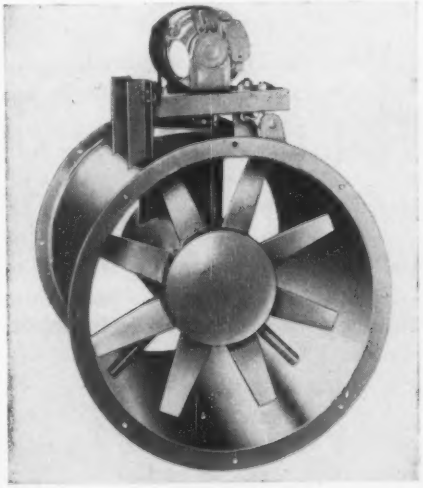
An outstanding feature of the controller is the wide choice of interchangeable elements, which permits the user to tailor the control to the application. Every major controller element —i.e., switching and indicating mechanism, switch type, temperature range, housing, bulb diameter, capillary length and materials of construction— is available in at least several variations or ratings.

Axial Flow Fans

Detroit Blower Corp., Dept. MF, 9867 Pacific Ave., Franklin Park, Ill.

A series of new aerodynamically designed axial flow fans feature wider blades which offer higher pressure characteristics with less operating noise. The welded steel wheels are available with four, six and eight blades.

Both belt driven and direct motor powered models are now available. Cradle-slung floor units, extended shaft models, adjustable-height floor stand fans for individual cooling, and larger models to meet heavy industrial cooling demands make up the line. Fan diameters run from 12 to 72 inches and have an air moving capacity of 1,200 to 100,000 cubic feet per minute.



Manufacturers' Literature

Chromizing Process

Chromalloy Corp., Dept. MF, 450 Tarrytown Road, White Plains, N. Y.

A new 4-page illustrated 3-color

folder describes the advantages and applications of the Chromalloy process for increasing the heat, wear and corrosion resistance of steel parts by high temperature diffusion of chromium into the surface.

The folder explains the two distinct results which the process brings about. The first is the Chromalloy case, a ductile surface alloy of iron and chromium, and the second is the Chromacarb case, a hard surface containing chromium carbide.

Photographs compare heat, wear and corrosion resistance of treated and untreated parts, and photomicrograph clearly shows diffusion structure of the case.

Centrifugal Pumps

Bart Labs., Div., Bart Mfg. Corp., Dept. MF, 229 Main St., Belleville N. J.

A new catalog sheet describing the new Flex-Seal centrifugal pumps has just come off the presses.

The literature describes a new two-piece seal which can be installed or replaced by any shop workman and requires no further adjustments. The seal, which is constructed entirely of extra low carbon stainless steel, is also shown in an "exploded view" that facilitates following operating and service instructions.

A special "rate of flow" chart clearly indicates the capacities and flow-rates of the models now in production.

Safety Solvent

Turco Products, Inc., Dept. MF, 6135 S. Central Ave., Los Angeles 1, Cal.

A new four-page folder, A-28, describes Turco-Solv, a true detergent-action safety solvent.

The folder contains three charts which cover toxicity, flash point throughout evaporation cycle and evaporation rate of the material as well as other commonly used cleaning solvents. Also included are a number of established uses for safety solvents.

Heat Exchanger

Niagara Blower Co., Dept. MF., 405 Lexington Ave., New York 17, N. Y.

Bulletin 132, Sectional Aero Heat Exchanger, illustrates and explains the functions of new equipment to provide cooling of liquids in industrial plants independent of a large supply of cooling water and with additional savings of installation and operating expenses.

Industrial Chemicals

Olin Mathieson Chem. Corp., Industrial Chemicals Div., Dept. MF, Baltimore 3, Md.

A new 20-page booklet has been issued describing briefly the firm's complete line of chemicals for industry.

The new booklet covers the company's organic, inorganic and specialty chemicals, listing characteristics, grades, containers and producing points for each. Principal uses are given for organic chemicals and specialties.

Barrel Finishing

Almco Div., Queen Stove Works, Inc., Dept. MF, Albert Lea, Minn.

A 52-page, profusely illustrated general catalog of the above firm's Supersheen barrel finishing equipment has been issued recently. It contains detailed basic material on barrel finishing.

Divided into two sections, the first mentions the method, its users, typical parts machined, and advantages. The second section deals with barrels, equipment, and supplies.

Self-Powered Cooling Controls

Sarco Company, Inc., Dept. MF, Empire State Bldg., N. Y. 1, N. Y.

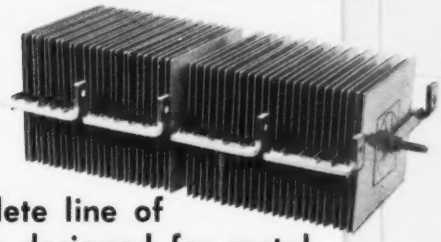
New Bulletin 710B describes self-powered cooling controls for compres-

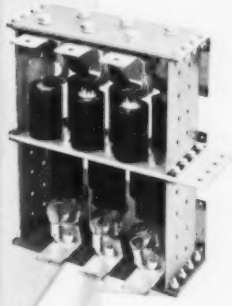
BULLETIN ER-108

Rectifiers?

you'll find all the answers at H-VW-M

Selenium and Germanium

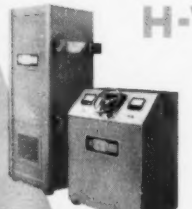




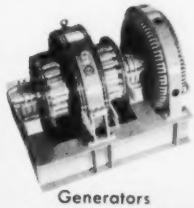
- **a complete line of rectifiers designed for metal finishing operations**
- **a complete line of rectifier controls to give you widest flexibility.**

Since H-VW-M manufactures *both* types of rectifiers—as well as low voltage generators . . . plus incorporating several choices of voltage controllers for electroplating, electroforming, anodizing and many other electrolytic applications—you can be sure an H-VW-M recommendation is the right recommendation.

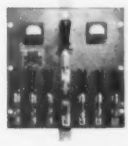
H-VW-M — THE ONE BEST SOURCE FOR



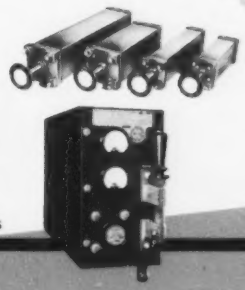
Rectifiers



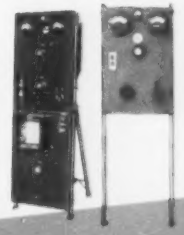
Generators



Rheostats



PR Controllers



Special Panels

HANSON-VAN WINKLE-MUNNING COMPANY

MATAWAN, N. J.

Manufacturers of a complete line of electroplating and polishing processes, equipment and supplies

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PLAINFIELD (N. J.) • ROCHESTER • ST. LOUIS • SAN FRANCISCO • SPRINGFIELD (MASS.)
UTICA • WALLINGFORD (CONN.)

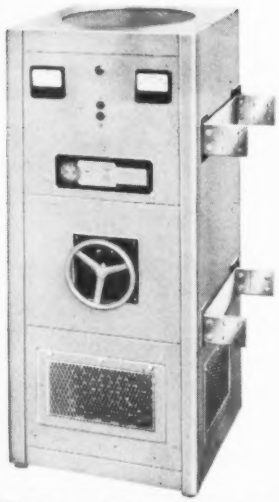
H-VW-M

the answer to every low voltage

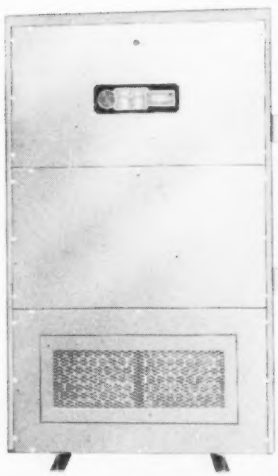
Selecting the right low voltage control equipment to give you proper control in your specific application is a major problem. But this problem is eliminated when you rely on H-VW-M. For H-VW-M produces the world's most complete line of low voltage direct current power equipment. That's why, when H-VW-M engineers make a recommendation you can be cer-

SELENIUM

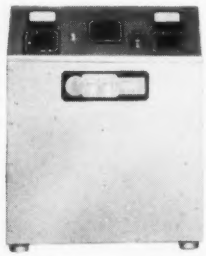
Highest quality and efficiency, flexibility, economy and low maintenance are the characteristics combined in H-VW-M's full line of self-contained and remote control Selenium Rectifiers. Possessing a high power factor and low ripple, these standard and bench-type rectifiers provide a voltage range of 6 to 48 volts DC.

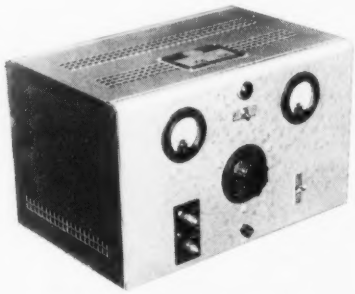


H-VW-M 2500 ampere, 9 volt self-contained rectifier with tap switch control.



H-VW-M remote controlled 5000 ampere, 9 volt rectifier with tap switch control.





H-VW-M small bench rectifier—50 amperes at 6 volts.

Greater effective selenium plate area per ampere—Individual plates are made of an aluminum alloy, with a layer of highest quality domestic triple-purified selenium.

Electrically balanced selenium plates—Each plate precision-tested to insure *electrically identical plates* in the same stack.

Corrosion-protected stacks—A coating of fungus- and moisture-proof material renders selenium stacks impervious to the corrosive conditions of average plating rooms.

Oversize transformers—Designed for continuous duty at KVA ratings of about 50% greater than the DC output KW.

Adaptability—Auto-transformer can be used for both 220 and 440 volt input, and is protected with coating of moisture- and corrosion-proof material.

Transformer compensating taps for stack aging—Also compensate for small variations in input voltage.

Complete overcurrent and undervoltage protection—Magnetic starter with 110 volt control circuit provides extra safety. Precision-calibrated thermostats over stacks cut out starter when temperature of stacks due to overload rises above safe limits.

High cooling capacity—Large plate area per ampere, plus powerful forced air cooling system, permits continuous operation with minimum heat rise—lengthens life of selenium stacks.

HANSON-VAN WINKLE-MUNNING CO. · MATAWAN, NEW JERSEY, U.S.A. · SINCE 1820

Ask for Bulletin ER-107

RECTIFIERS-

high current rectification problem.

tain their recommendation is unbiased and in your best interest So when it comes time to select power equipment, call your nearest H-VW-M technical representative. He'll help you specify the right unit and type of control for maximum efficiency and economy in your plant.

GERMANIUM

Hanson-Van Winkle-Munning's new low voltage self-contained and remote control germanium rectifiers are specifically designed for the electroplating industry. The germanium junction, with its efficiency and economy of operation, compactness and vast improvement in voltage regulation, opens a new and wider field for metallic rectifiers in the plating industry.

Outstanding efficiency —At full load, with output voltages of 15 volts and above, the germanium rectifier is capable of efficiencies in excess of 90%. Even at lower voltages, efficiencies are exceptionally high.

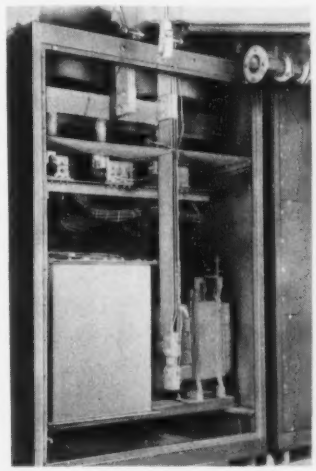
Improved voltage regulation—From no load to full load, voltage regulation of 8% or better can be maintained—no need for expensive automatic voltage stabilization devices in most cases.

Forced air cooling—Air is drawn up through the equipment, across junctions, out through the fan at the top.

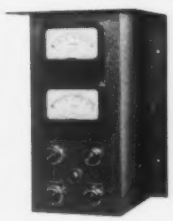
Electrical protection—Overload and DC line shorts guarded against by inexpensive, replaceable link-type fuses. Overcurrent relay in DC circuit can provide additional protection when desired.

Designed for continuous 24-hour-a-day operation—At full capacity. Voltage range is from 6 to 48 volts, with current output from 1000 to 10,000 amps. Higher ratings are available for special applications.

Sturdy cabinet housing—All component parts located within housing. H-VW-M Germanium Rectifiers—though they require little maintenance—are easy to service.



Rear view, with panel open of a 3000 ampere, 15 volt germanium rectifier.



Remote control box with meters and start-stop and raise-lower buttons—for use with H-VW-M Rectifier incorporating motor-driven variable auto-transformer control.

Illustration of a compact germanium junction, the core of new unit.

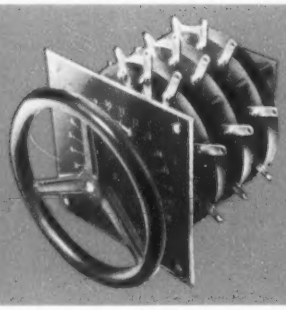
Ask for Bulletin GR-100

SEE NEXT PAGE FOR CONTROL FLEXIBILITY AND SUGGESTED APPLICATIONS

CONTROLS *for both*

Selenium and Germanium RECTIFIERS

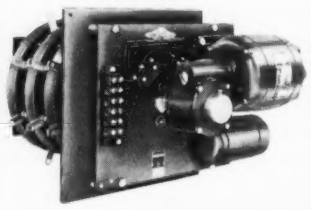
Selecting the proper control is of utmost importance for the most efficient, flexible and economical operation of your rectifier. H-VW-M offers the widest possible selection of controls and control combinations to meet every requirement. Some application suggestions are listed below. Ask for further recommendations from your H-VW-M representative—you can be confident that you'll get top performance from your electrical equipment.



Manual Tap Switch Control

For both self-contained and remote controlled units. Remote control type incorporates tapped auto-transformer in control cubicle. In self-contained units these are located in basic cubicle. Provides 22 positions of voltage adjustment from zero to rated voltage.

Motor Operated Tap Switch Control

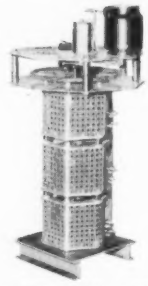


For simple pushbutton control of output from remote location. Used in conjunction with tapped auto-transformer. A small remote control box can be mounted on side of tank or other convenient place. Meters, pilot light, raise-lower and start-stop pushbuttons also on small remote cubicle.

Continuously Variable Auto-Transformer

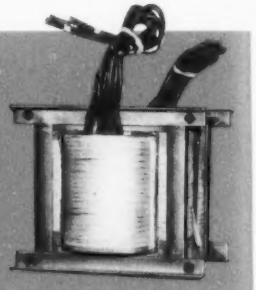
Either manual for small rectifiers or oil immersed, motor driven for larger ratings. This is the best method of voltage control since full stepless control of output voltage can be obtained from zero to rated voltage. It also achieves highest efficiency.

A raise-lower pushbutton as on motor operated tap switch control provides control.



Saturable Core Reactor

Wholly electrical in operation with no moving parts gives smooth voltage control from 10% to 100% of rated voltage providing minimum of 10% current load is drawn. Rheostat mounted on small remote control cubicle providing manual adjustment.



Automatic Voltage Stabilization

Where close regulation of DC voltage is desired to compensate for wide load changes in tank without adjusting voltage manually, a special device will automatically maintain voltage at pre-set amount. Either a voltage sensing panel in conjunction with a motor driven, oil immersed, continuously variable auto-transformer is used, or a special magnetic amplifier in connection with a saturable core reactor. Automatic constant current can also be provided.

Automatic Programming

Where different voltages are desired for special plating applications, an automatic programmer using a system of timers and controls will set the output at one voltage; operate at that voltage for pre-set time; change to another voltage at a pre-set rate; operate at new voltage for a certain time and then shut the rectifier off. There are also more simplified versions. Method of control is motor-operated continuously variable auto-transformer.

APPLICATION SUGGESTIONS

Use	Recommended Control
Batch Tank Plating	Manual tap switch.
Batch Tank Plating with wide load variations and high production	Motor operated variable auto-transformer. or motor operated tap switch.
Barrel Plating	Manual tap switch. No control rectifier.
Cleaning & Pickling	Manual tap switch. No control rectifier.
Conveyor—many stations	Manual tap switch (remote control). Motor operated tap switch. Saturable core reactor. Motor operated continuously variable auto-transformer.
Conveyor—few stations	Automatic voltage stabilization with variable auto-transformer. Automatic voltage stabilization with saturable core reactor.
Chrome Strike in combination with Plate Sulphuric Anodizing	Automatic programming with variable auto-transformer or special series hook-up. Manual tap switch. Motor operated tap switch. Saturable core reactor.
Color Anodizing	Automatic constant current with variable auto-transformer. Automatic constant current with magnetic amplifier and saturable core reactor.
Chromic Anodizing	Automatic programming with variable auto-transformer. Combination automatic constant current and automatic voltage stabilization with variable auto-transformer or saturable core reactor.
Electrolytic Metal Refining	Automatic current control with saturable core reactor.

H-VW-M

HANSON-VAN WINKLE-MUNNING COMPANY, MATAWAN, N. J.

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INDUSTRY'S WORKSHOP FOR THE FINEST IN PLATING AND POLISHING PROCESSES • EQUIPMENT • SUPPLIES

ors, stills, solvent coolers, degreasers, il coolers, small engines, condensers, tc. It includes operational drawing nd hook-up sketches.

Sprayable Plastisol

Metal & Therm't Corp., Dept. MF, Rahway, N. J.

A four-page, photo-illustrated bulletin, now available, describes the company's latest development in sprayable plastisols, Unichrome "Super 5300" plastisol coating. The bulletin, SP-1, explains how the specially formulated plastisol can be sprayed in coatings up to 60 mils thick in a single application —even to cold vertical surfaces.

Applications for Coated Abrasives

Minnesota Mining and Mfg. Co., Dept. MF, 900 Fauquier St., St. Paul 6, Minn.

A new 10-page booklet illustrates how several leading appliance manufacturers are cutting costs and improving finishes with 3M coated abrasives in various forms.

The booklet makes case history presentations of several abrasive operations, including pre-finishing, weld grinding and blending, removing imperfections, and finishing and polishing.

Types of coated abrasives illustrated in use are belts, sheets, discs and "PG" (polishing and grinding) wheels.

Acid Proof Construction

Pennsylvania Salt Mfg. Co., Dept. MF, Three Penn Center Plaza, Philadelphia 2, Pa.

A recent addition to the firm's Corrosioneering service is a new series of engineering drawings incorporating the latest technology in construction methods for acid resistant brick installations.

Graphically diagrammed are details of acid proof masonry construction for six typical installations: a pump base, column pad, tank outlets, bell and spigot joints, floors and trenches.

Dust Collector

Pangborn Corp., Dept. MF, Hagerstown, Md.

The new Ventrijet, made for the wet collection of industrial dusts, is illustrated and described in a new 8-page brochure (Bulletin No. 920).

Fifteen photographs and drawings show the unique action. Dimensions, weights and capacities are presented in three tables.

Barrel Finishing

BMT Mfg. Corp., Dept. MF, Elmira Heights, N. Y.

Slide-Honing, the modern precision tumbling process, is described in a new and revised brochure issued by the above company.

Industrial Ovens

Kirk & Blum Mfg. Co., Dept. MF, Cincinnati 9, O.

"Ovens for Industry," a new 36-page catalog, shows a wide range of representative industrial oven installations. Photographs and drawings are used to illustrate the varying sizes and types of installations, providing a cross-section of the many kinds of ovens designed, fabricated and installed for industry.

Included are twin rock wool ovens and cooling tunnels, foam rubber dryers, battery plate dryers, metal tube dryers, permanizers and pharmaceutical product dryers; also ovens for testing paper products drying, motor stator baking, automotive accessories, and a special pit-type oven for baking varnish on armatures.

Chemical Resistant Coatings

Metal & Thermit Corp., Dept. MF, Rahway, N. J.

A new four-page, illustrated bulletin, Chem C-2, describes three general classes of chemical-resisting organic coatings that have been developed to meet the needs of processing industries. The three classes are 1) Ucilon coating systems applied like paint for general corrosion control; 2) Unichrome plastisol compounds for heavy-duty service, and 3) Unichrome special materials for lining steel drums and tanks.

The bulletin describes the 4000 Series Plastisols for dip application, the 5300 Series for spray applications and the recently introduced "Super 5300," which is a sprayable plastisol that permits coatings up to 60 mils thick in a single application.

The bulletin points out the advantages of both phenolic tank linings and plastisol linings. It also describes basic types of vinyl, phenolic, epoxy and plastisol drum linings.

Installation of Rigid Plastic Pipe

The B. F. Goodrich Co., Plastic Products, Dept. MF, Marietta, O.

An eight-page illustrated bulletin on its line of high impact rigid Koroseal pipe, fittings and valves has been published by the above company.

The brochure explains how the pipe is installed, reviews product applications and describes physical properties. Also described is the use and installation of Koroseal valves. The back page is devoted to a chart listing common chemicals handled by the pipe, fittings and valves.

Paint Manual

Plastics and Synthetics Div., The U. S. Stoneware Co., Dept. MF, Akron 9, O.

A new paint manual, Tygon Protective Coatings Bulletin No. 760, is designed for use as a practical work book, presenting useful painting data in the form of charts, tables, diagrams and illustrations. Virtually all factors relating to the use of these protective coatings in mild to severe corrosive service are covered in detail.

The complete family coatings and related primers are presented along with surface preparation, priming, application methods and maintenance instructions. Care and cleaning of brushes and spray equipment is explained. A table of chemical resistance is included which gives the resistance rating of each coating to over 200 corrosive agents. Of special interest is the section dealing with ATD Hot Spray Paint which gives a detailed explanation of this imporatnt new system of protective maintenance painting. Also discussed is a proven method of successfully priming rusty surfaces without previous surface preparation using Tygorust, a "no-prep" primer.

Limitations of each coating are given and overall cost factors relating to specialized coatings in the maintenance program are discussed.

Rust Preventives

Daubert Chemical Co., Dept. MF, 333 N. Michigan Ave., Chicago 1, Ill.

A new rust preventive selector chart has been designed to assist metal working firms in the selection of a suitable rust preventive to meet storage and shipping requirements for spare parts, tools, and machines. The chart is divided into two sections, one of which deals with the protective properties of a group of Nox-Rust products while the second section describes the physical properties and coverage afforded by each of these products.

Test Chamber

Tenney Engineering, Inc., Dept. MF, 1090 Springfield Road, Union, N. J.

An attractive, four-page folder discusses the firm's TR chamber especi-

ally designed for accurate controlled low/high-temperature and relative humidity testing.

The two-color folder contains informative details regarding applications, performance, construction, and specification data about the TR line. These chambers are designed to meet temperature and humidity test requirements of several military specifications.

BUSINESS ITEMS

New Appointments at M & T

Bernhard W. Weber has been named to head manufacturing operations of *Metal & Thermit Corp.*, with the title of manager of manufacturing. He succeeds *Walton S. Smith* who recently retired as vice-president in charge of manufacturing. *H. Alfred Rack*, formerly manager of engineering, will take over Mr. Weber's former post as production manager.

Mr. Weber became associated with Metal & Thermit in 1949, after 16 years with American Can Co. as superintendent and plant manager. He was manager of M & T's Chicago plant from 1949 to 1952, when he was made production manager of the company with headquarters in New York City. Mr. Weber is a graduate of Oregon State University and holds the degree of Bachelor of Science in Mechanical Engineering.

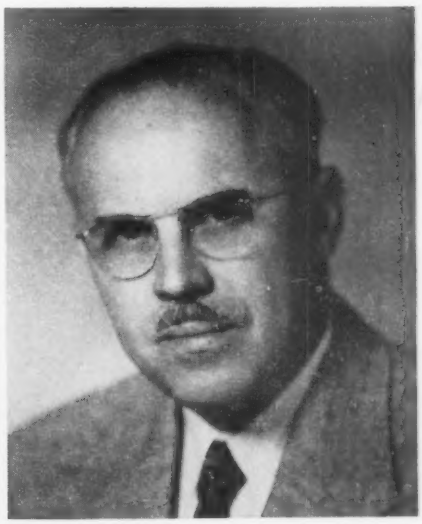
Mr. Rack joined the company in 1944, after a 20-year career with Western Electric and Western Union. Starting as maintenance engineer in Chicago, he was put in charge of process engineering and later was manager of the Organic Chemical Department before becoming manager of engineering. He was graduated from Brooklyn Polytechnic Institute as a chemical engineer, and is a member of the American Institute of Chemical Engineers and the American Society of Mechanical Engineers.

David Birger Orden has been named Latin-American representative. His headquarters will be in Mexico City, and he will contact distributors and direct customers in Latin-America.

Mr. Orden has spent several years in Latin-America, and has been specially trained to offer technical assistance in applications of the firm's products.

A native of Copenhagen, Denmark,

Bernhard W. Weber



H. Alfred Rack

David Birger Orden

Donald W. Oakley

Mr. Orden received the degree of Bachelor of Commercial Science at Copenhagen and later undertook graduate study in Foreign Trade and Business Administration at Neuchatel and Geneva, Switzerland.

In former connections he has represented in Latin-America the firms of Lopez Hermanos, S. A., of Spain; Esbjerg Maelkeindustri, A.S., of Denmark and Metallica International, S.A., of Panama.

He is an associate member of American Welding Society.

Donald W. Oakley has been transferred from assistant production manager to technical advisor to the president. In this post he succeeds *A. James Fisher* who was recently named general sales manager.

Mr. Oakley became associated with the company in 1947 after 15 years as research chemist and development engineer with DuPont. His first position was superintendent of semi-works, in organotin development. He was made assistant manager in 1952, and assistant production manager of the company in March, 1956.

Mr. Oakley holds a degree in chemical engineering from Columbia University and also attended the Columbia graduate schools of engineering and business administration. A member of the American Institute of Chemical Engineers, he is chairman of the New Jersey section, and a member of the national program committee on unit operation.

Infilco Promotes R. W. Schneider and J. P. Manger

Promotion of a former service engineer, *R. W. Schneider*, to field sales engineer for Indiana, Michigan and Ohio has been announced by *Infilco Inc.*

He replaces *J. P. Manger* who has been transferred to company headquarters at Tucson, Ariz. to work in sales project engineering.

Thermo-Panel Div. of Dean Products Appoints Representatives

The *Thermo-Panel Coil Div.* of *Dean Products, Inc.*, 616 Franklin Ave., Brooklyn 38, N. Y., announces the appointment of the following new representatives:

Arthur Forsyth Co., 2800 15th Ave., West Seattle, 99, Wash.—to cover all counties in the State of Washington except Wahkiakum, Cowlitz, Skamania,

Clark, and Klickitat. In the State of Idaho, only the counties of Boundary, Bonner, Kootenai, Benewah, Latah, Clearwater, Nez Perce, Lewis, and Shosbone. All of Alaska.

Jobe & Co., 344 E. 33rd St., Baltimore 18, Md.—to cover the complete State of Maryland with the exception of the counties of Garrett and Alleghany and Washington, D. C.

Charles C. Plummer, 4343 South 36th St., Arlington, Va. — to cover Washington, D. C. and the State of Virginia.

Cotton & Kent Co., 2510 Travis St., Houston 6, Tex.—to cover the State of Texas south of and including the counties of Kinney, Uvalde, Medina, Bexar, Comal, Hays, Travis, Williamson, Milan, Robertson, Leon, Houston, Cherokee, Rusk, and Panola.

Raybestos-Manhattan Sales Appointments

Creation of a new Eastern Sales regional manager, has been announced by the *Manhattan Rubber Division* of *Raybestos - Manhattan, Inc.*, Passaic, N. J. This new region combines the New York, Philadelphia and North Jersey Districts.

R. F. Teeling, manager of the region, joined the division in 1911. He was made asst. branch manager, North Jersey sales, in 1940, becoming manager in 1948. In his new capacity he will coordinate the activities of the New York, Philadelphia and North Jersey Districts.

J. T. M. Frey is manager of the North Jersey District. He started in the New York office in 1937, and was made assistant manager, New York Branch, in 1948.

Headquarters for the Eastern Sales Region offices will be located at 500 Fifth Ave., New York, N. Y.

George L. Stutz Named President of George A. Stutz Mfg. Co.

George A. Stutz, founder of the *George A. Stutz Mfg. Co.*, has been elected chairman of the board, and his son, *George L. Stutz*, is now president.

George L. attended Northwestern University in Evanston, Ill., where he received a Bachelor of Science degree in 1943. Upon graduation he enlisted in the Army Air Corps, and was sent to the University of Wisconsin at Madison. After completing preliminary studies there, he was sent to the University of Chicago and was graduated

George A. Stutz

George L. Stutz

as a meteorologist. After the war he was honorably discharged and then was employed by the Stutz Mfg. Co. as a salesman for eleven years.

Ronald J. Lang Joins Wyandotte Chemicals

Ronald J. Lang recently joined the industrial sales and service staff of *Wyandotte Chemicals Corp.* A native of Detroit, he is a graduate chemist of Detroit Institute of Technology and will headquarter in the firm's Motor City office.

Mr. Lang is a member of the A.E.S. and has experience with two chemical firms in pilot plant, research, development and technical service activities. He has been thoroughly schooled by company personnel in effective application of modern metal cleaning materials.

Ronald J. Lang

New Bart-Messing Representative

Rene Sonnenfeldt was recently appointed sales engineer for the *Bart-Messing Corp.*, Belleville, N. J. Prior to joining the company he held sales engineering positions for Dutch companies which took him to several Euro-

Rene Sonnenfeldt

pean countries "trouble-shooting" and on service calls. In the United States, he held positions with American Plating, Inc., Zelionopole, Pa., and Bart Labs., Belleville, N. J.

Sonenfeldt's position entails sales of major equipment such as rectifiers and plating units, as well as precious metals salts and processes in behalf of *Sel-Rex Precious Metals, Inc.*, an associated company.

New Sales Representative for Hooker in Midwest

Ernest F. Blew, sales representative, has been assigned to handle chemical sales in the Wisconsin, Minnesota, and Upper Michigan peninsula areas for *Hooker Electrochemical Co.*, Niagara Falls, N. Y. Mr. Blew reports to the Chicago district chemical sales office headed by *William L. Gillespie*, district sales manager for chemicals.

A 1951 chemical engineering graduate of Rensselaer Polytechnic Institute, Mr. Blew then came to the firm in the process study group at Niagara Falls and soon was transferred to technical sales service work. He recently returned after two years of Army service. Mr. Blew replaces *Victor M. Morgan* who, after two years in the territory, has returned to Niagara Falls to work in the plant engineering department.

Kelite Appoints Hennessy

Wm. J. Hennessy has been appointed Eastern regional sales manager for *Kelite Corporation*, manufacturers of industrial chemicals and steam cleaning equipment. The Eastern region is made up of the Middle Atlantic and North Atlantic states, plus the State of Ohio.

Wm. J. Hennessy

Mr. Hennessy was formerly associated with Pennsylvania Salt Mfg. Co. as sales supervisor, Metal Processing Dept. His background includes experience in the industrial cleaning chemical industry, with the majority of that experience in metal finishing, and heavy industry sales and sales management.

Mr. Hennessy is active in the American Electroplaters' Society, of which he has been past president and member board of directors, of the Pittsburgh branch. He has also been active in the Central District Enamelers' Ass'n.

Walton Smith Retires; Directed M & T Mfg.

After 37 years of service with *Metal & Thermit Corp.*, most recently as head of the company's manufacturing operations, *Walton S. Smith* has retired as vice-president in charge of manufacturing.

Joining the firm in 1919 as a mechanical engineer, he became assistant superintendent of the Carteret, N. J., plant in 1925 and superintendent in 1937. He was elected vice-president in 1942 and became a director in 1943. He will continue as a director and consultant for the company.

Mr. Smith was graduated from the University of Michigan in 1912 and served as a captain in the Coast Artillery Corps during World War I. He is a member of the American Institute of Chemical Engineers, American Electroplaters' Society, American Society for Metals and The Electrochemical Society.

Walton S. Smith

Dow Expands Magnesium Finishing Services

Dow Chemical Co. announced an expansion of its finishing technical services for users of magnesium.

Under the program, four research personnel of the metallurgical laboratory will be transferred to the company's Magnesium Technical Service & Development group and will devote full time to the finishing projects of individual customers.

Making the transfer to Technical Service will be *P. F. George, H. K. DeLong, P. C. White* and *D. E. Ritzema.* George will have general supervision of the over-all program. DeLong will assist George in directing the finishing phase.

Vouglas Appointed Sales Engineer in Federated Metals Plating Department

Joseph Vouglas has been appointed sales engineer in the Plating and Electrochemicals Department of *Federated Metals Division* of *American Smelting and Refining Co.* Mr. Vouglas will make his headquarters at the Newark office and cover the Eastern sales territory which embraces New York, Connecticut, New Jersey and Pennsylvania. Formerly associated with General Cable Corp. and Houdaille-Hershey Corp., Mr. Vouglas has been in Federated's Plating Department for five years. He is a member of the American Electroplaters' Society.

Rampe Increases Manufacturing Space

Rampe Mfg. Co., of Cleveland, Ohio, manufacturers of tumbling equipment, announce that they are adding an additional 50% of manufacturing space. The additional manufacturing space is at the same address.

Wagner Brothers Add V.-P., New Factory Branch

Wagner Brothers, Inc., Detroit manufacturers of plating automation, chemicals and supplies, has announced the

Jack Keyes

election of *Jack Keyes* as vice president in charge of Western Michigan sales. Simultaneously, it was announced that a factory branch has been established in Grand Rapids to service the area, including laboratory, warehousing and technical service facilities. *Richard Watson* has been appointed to manage the office, cooperating with Keyes. This is the second direct sales office to be announced by the company in thirty days, a similar office having been set up in Cincinnati. The Grand Rapids address is 2417 Eastern Ave., S.E.

Mr. Keyes has been a sales engineer with the company for eight years covering the Western Michigan territory. Prior to that he had a similar position with Hanson - Van Winkle - Munning. Mr. Watson, a chemical engineering graduate of the University of Detroit,

Richard Watson

has held technical positions at Wyandotte Chemical Co., followed by several years as a technical sales engineer.

Simons Joins NRC Research Division Staff

John C. Simons, Jr. has joined the staff of *National Research Corp.* He will serve as director of the applied physics department in the company's research division where he will be responsible for long range product development for the equipment division as well as special projects for research.

Dr. Simons' background includes four years at Massachusetts Institute of Technology where he was project engineer in charge of research on analogue computers and fire control systems. Earlier he served for three years with the Atomic Power Division of Westinghouse Electric Corp. where he was in charge of work on control systems and techniques for nuclear power reactors including the one installed on the U. S. S. Nautilus.

A native of Philadelphia, Dr. Simons attended public schools in the area and the Drexel Institute of Technology where he received his B.S. in Chemical Engineering. Following four years of active duty with the Navy, he was released with the rank of Lieutenant. He then entered the graduate school of the Massachusetts Institute of Technology where he received his Ph.D. in physics.

Dr. Simons holds memberships in the American Physical Society, the Institute of Radio Engineers, and the American Institute of Chemical Engineers. He is a member of Tau Beta Pi. With his wife and two children, he resides in Belmont, Massachusetts.

Nickel Processing Corp. Completes Record-Breaking Year

Nickel Processing Corp., a subsidiary of *National Lead Co.*, has announced the completion of another record-breaking year in the operation of the U. S. Government-owned nickel plant in Nicaro, Cuba. The plant produced 31,460,000 pounds of nickel in the twelve months' period ending June 30, topping the previous fiscal year production of 29,504,000 pounds by 1,956,000 pounds, and surpassing the plant's rated capacity.

The Cuban installation was able to compile the new record despite the fact that during the period an extensive

expansion program was underway. When the 75 per cent enlargement of the plant is completed, annual rated production will be increased to 49,000,000 pounds of the highly-strategic metal, now in very short supply.

Metalwash Machinery Corp. Appoints Representative

Metalwash Machinery Corp. of Elizabeth, N. J., announces the appointment of *Ralph C. Schwarz & Sons*, Rochester, N. Y., as its representatives in the Western Area of New York State.

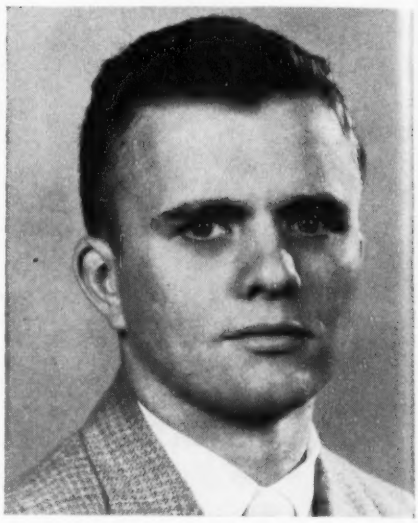
The new representatives will handle the complete line of processing machinery for washing, pickling, drying, phosphatizing, heat treating, ultrasonic cleaning, degreasing, and complete finishing systems.

The principals in the Schwarz organization are *Ralph C. Schwarz*, *Ralph C. Schwarz, Jr.*, and *Peter D. Schwarz*, all engineering graduates of Cornell University.

The Schwarz organization has been active in the Western Area of New York State for 35 years, calling on both industrial and utility accounts, and specializing in machine industries where the heat treatment of metals and metal finishing are encountered.

The Eastern Area of New York State will continue to be serviced for Metalwash by *W. D. Hornbruch*, of Scotch Plains, N. J.

Webber & Reynolds in New Positions at Udylite



A. E. Webber

A. E. (Bud) Webber has been promoted to the position of sales engineer by *The Udylite Corp.* His assignment is the Pittsburgh area, working under the supervision of the Cleveland office.

For the past 3 years Bud has served the firm's customers as a laboratory technician out of Detroit. His previous experience included work on water purification while in the U. S. Army. He is a Bachelor of Science graduate of the University of Detroit with a chemistry major.

Russell E. Reynolds who has served in the Pittsburgh area as sales engineer for the past three years, moves into the Detroit District on July 1st. He will

serve as the company representative in the Northwest section of Michigan.

Russell E. Reynolds

Reynolds has a background of chemical engineering education and years of training in process control, research and production supervision.

H-B Instrument Company Acquired Tagliabue Mfg. Co.

The Tagliabue laboratory and industrial thermometer and hydrometer division has been purchased from *Weston Electrical Instrument Corp.*, by the *H-B Instrument Co.* of Philadelphia, Pa.

Manufacturing facilities and sales offices of the Tagliabue Division, located in a new plant at 87 Sewell St., Hempstead, N. Y. will be ready for normal operation by August 1st. Executive offices will be at 263 W. Bristol St., Philadelphia 40, Pa.

Nicholas Munisteri, who has been associated for many years with the Tag line of instruments, is now vice-president in charge of sales for the new company. His office is in the Hempstead plant.

The Tagliabue line has been in continuous operation since 1834. This consolidation brings together two of the oldest companies specializing in the manufacture of scientific instruments utilizing glass and mercury.

Detrex Completes Transfer of Stock

Detrex Chemical Industries, Inc., formerly Detrex Corp., has completed the transfer of all outstanding capital stock from the previously, jointly-held, Hooker-Detrex, Inc., and has also completed the merger of the Detrex Corp., Hooker-Detrex Inc., and the Detrex Realty Co. into Detrex Chemical Industries, Inc.

As a result of these negotiations, Detrex will own and operate the entire facilities at Ashtabula, Ohio, which are devoted to the manufacture of trichlorethylene and anhydrous hydrogen chloride. The firm has also secured for sale the trichlorethylene production of the Tacoma, Wash., plant.

With the taking over of these facilities, the company becomes the largest producer and distributor of trichlorethylene for direct sale to industry.

Ten Eyck Promoted by Goodyear

Richard C. Ten Eyck has been promoted to manager of Tank Lining and Industrial Rubber Covered Roll Sales Department by the *Goodyear Tire & Rubber Co.* Ten Eyck replaces *R. M. Junker*, who has left the firm.

A former member of Goodyear's training program for college graduates, Ten Eyck joined the firm after completing business administration studies at Lehigh University in 1949. He was

Richard C. Ten Eyck

assigned to the company's Industrial Products Division in 1950 and attached to the Tank Lining Sales Department.

In 1952 he was promoted to field representative at Dallas, Texas, then transferred to Minneapolis, Minn. in 1955.

A native of Elizabeth, N. J., Ten Eyck served in the army infantry and engineers from 1944 to 1946.

National Bureau of Standards to Be Relocated

A tract of approximately 550 acres of land near Gaithersburg, Md., has been selected for relocation of the Washington laboratories of the *National Bureau of Standards*. The move will permit the Bureau to plan new buildings to replace present facilities, which over the past 50 years have become inadequate for current needs.

The new site was selected after careful consideration as most suited to the special requirements of the Bureau's scientific and engineering programs. The choice was based upon a number of factors, including accessibility by railroad and highway as well as topography for certain technical projects.

The Congress appropriated funds for site acquisition and preliminary planning early in June after details about the proposed site had been presented to House and Senate Appropriations Committees. Plans for the site have been given to the National Capital Planning Commission and to the Regional Planning Council, and it is expected that these groups will work with the Bureau in utilizing the land. The General Services Administration will participate in planning and will supervise construction. Transfer of operations to the new location is expected to be completed in about five years.

The Bureau occupied its present site on Connecticut Ave. in Washington in 1903. Since that time its responsibilities have greatly increased, largely as a result of the rapid expansion of technology and the growth of scientific research. Extensive programs of research and development must now be conducted in the physical sciences and engineering to meet the needs of science and industry for new and improved standards and measurement methods. The new site will enable the Bureau to plan for a more up-to-date plant consistent with its continually increasing responsibilities.

Many of the buildings on the present site are temporary in nature, and even the permanent buildings are outmoded from the viewpoint of modern technology. Renovation and modernization of this plant would be very costly, amounting to more than half the estimated cost of a complete new facility. Space for further expansion is also lacking on the present site.

It is expected that the new location

will make possible a more modern research operation in structures that can be very efficiently managed. In addition, the new site will provide the benefits of a rural location where scientific programs can be undertaken without interfering in community life and without urban interference to important Bureau projects. The rural location will remove the Bureau's work from the variety of mechanical, electrical, and atmospheric disturbances present in a city and will reduce the effect of these forces upon precise scientific measurements.

In addition to its Washington laboratories, the Bureau maintains a major research center in Boulder, Colo. and 20 widely scattered field stations. The Boulder Laboratories are concerned with radio propagation research, radio standards, and cryogenic engineering. Most of the field stations are engaged in gathering data on radio propagation.

Hooker Electrochemical and Oldbury Electro-Chemical Negotiating for Merger

The officers of *Hooker Electrochemical Co.* and *Oldbury Electro-Chemical Co.*, both of Niagara Falls, N. Y., announced, on July 12, that they are negotiating for a merger of Oldbury into Hooker Electrochemical by the issuance of 450,000 shares of Hooker common stock in exchange for the 10,000 shares of Oldbury presently outstanding.

Should the current negotiations result in an agreement approved by the boards of directors of both companies, it is anticipated that the proposal will be submitted to the stockholders of both companies at special meetings to be held this fall.

Oates Joins Magnuson

Magnuson Products Corp., manufacturers of specialized chemical cleaning compounds, has designated a new sales representative, *Clifford Oates*. In Central New York State, working out of Syracuse, he will cover accounts and prospects in the manufacturing, transportation, and paper mill industry as well as other business.

Mr. Oates is a native of up state New York, and his business and sales career has been in New York. Besides the supply industry to the metal finishing field, Mr. Oates has been active in that business on operation, estimation, and quotation. He is a member of the New York branch of the American Electroplaters' Society.

Clifford Oates

Infilco Promotes J. M. Young — Lee Hiser

Joseph M. Young, formerly field sales engineer for *Infilco, Inc.* in the Southwest area, has been transferred to headquarters of the Ion-Exchange Dept. of the company in Tucson, Ariz.

Lee Hiser

Harry N. Buchanan

Henry Mahlstedt

Lee Hiser, formerly in the engineering department in Tucson, has been appointed field sales engineer for the Southwest territory in place of Mr. Young. His headquarters will be in Houston, Tex.

Metal & Thermit Names New Sales Executives

In line with its current program of expansion and product diversification, Metal & Thermit Corp., has announced a number of new sales executive appointments.

Harry W. Buchanan, III, has been named sales manager of chemicals, metals and plating products. Mr. Buchanan has been associated with the company since 1947 in various research, production and sales capacities. In 1955, as sales manager of the Chemical Division, he was granted a leave of absence for one year to accept a Sloan Fellowship for advanced study at M.I.T. He has just returned from this assignment.

He is a graduate of Renssalaer Polytechnic Institute and holds membership in the American Electroplaters' Society, Society of Plastics Engineers and American Chemical Society.

Henry Mahlstedt has been appointed

George Betz

Donald R. Meserve

Edwin M. Tinnon

product manager for plating products. He has been connected with associated companies of Metal & Thermit since 1927; he was for seven years sales manager of chromium plating products. He holds a degree in Chemical Engineering from Polytechnic Institute of Brooklyn.

George Betz has been named product manager for chemicals and metals. He has been connected with the company since 1944 as sales manager of ceramic materials and chemicals. He is a Fellow of the American Ceramic Society, a member of the New Jersey Ceramic Association and the Institute of Ceramic Engineers.

Donald R. Meserve will serve as product manager for coatings. He has served with Metal & Thermit associated companies in several capacities since 1942, most recently as assistant manager of sales of electroplating and coating. He is a member of the National Association of Corrosion Engineers, National Paint and Varnish Association, American Management Association and Research Institute of America.

Edwin M. Tinnon has been placed in charge of distributor relations. In this newly created position, he will also report to Harry Buchanan. Mr.

Timnon joined the firm in 1949, serving as senior sales engineer of industrial chemicals. He is a member of American Electroplaters' Society and American Wire Association.

Rice to Head Robertshaw-Fulton West Coast Lab

Harold W. Rice has been appointed director of the West Coast research & development laboratory of *Robertshaw-Fulton Controls Co.* He succeeds *H. W. Geyer,* who has resigned.

Mr. Rice has been with the company for more than twenty years. He started as a draftsman for the company's Grayson Controls Division and advanced to positions as engineer and development engineer. For a time he was in charge of an experimental laboratory at the division.

He attended Los Angeles City College and later completed his education at the University of Southern California, where he received his Bachelor of Engineering degree (magna cum laude) in 1946.

He is a member of the American Society of Mechanical Engineers, American Society for Metals, Instrument Society of America, Pacific Coast

Harold W. Rice

Gas Association, American Gas Association, American Institute of Physics and the Gas Appliance Engineers Society.

Wirsig Appointed by Speer Carbon

Stanley S. Wirsig has been made manager of graphite development and customer technical service of *Speer Carbon Co.*.

Mr. Wirsig will be headquartered in St. Marys, Pa. He will be responsible for developing new industrial applications for graphite, and assisting customers in the utilization of this product.

Prior to joining Speer, Mr. Wirsig was assistant to the president of the Kordite Co., and previously, technical director of the roaster plant of the Zinc Smelting Division of St. Joseph Lead Co. at Monaca, Pa.

Mr. Wirsig was graduated from Syracuse University in 1939, with a B.S. degree in Chemical Engineering. In June, 1955 he obtained his M.B.A. at the Harvard Graduate School of Business Administration.

Michigan Chrome Acquires Pyramid Plastics

Michigan Chrome and Chem. Co., Detroit, Mich., announces the acquisition by that company of the assets of *Pyramid Plastics Co.*, of Chicago.

Michigan Chrome, a major manufacturer of vinyl plastisols and specialized industrial coatings, thus acquires the facilities of an established, specialized industrial extruder.

The acquisition of Pyramid adds to the present line a complete line of tapes, tubes, rods, shapes, coatings,

and specialized products for industrial use, fabricated from practically all thermoplastic materials such as Saran, vinyl chloride, vinyl chloride-acetate, polyethylene, polystyrene, styrene copolymers, and cellulosic materials.

Pyramid Plastics will continue operations under the same name with *James Palmer* continuing as president and general manager.

Also announced was the formation of *Michigan Chrome and Chemical Ontario, Ltd.*, for the manufacture and distribution of Micro products in Canada.

Electroplating Scholarship Winners Announced

The *Joseph B. Kushner Electroplating School* of 115 Broad St., Stroudsburg, Pa., has announced the winners in its recent *Electroplating Know How* Scholarship Contest, as selected by the board of judges, *Nat Hall*, editor of METAL FINISHING, *Archy Doria*, editor of *Plating* and *Ezra Blount*, editor of *Products Finishing*.

First Prize, a scholarship for the home study course in modern electroplating given by the school, was won

Robert C. Cripe

by *Robert C. Cripe*, of San Antonio, Tex.

Mr. Cripe is the process control chemist of the plating unit at the Kelly Air Force Base in San Antonio. He graduated from Goshen College, Goshen, Ind., with a B.A. in chemistry in 1941, took graduate work in chemistry at the University of Chicago, and served three years in the Air Force, leaving the service as a captain in 1949. Since that time he has been associated with his present job. He is married, has one son and is presently the librarian of the San Antonio branch of the *American Electroplaters' Society*.

Second prize was won by *Lester J. Erckman*, a senior standards engineer with Link Aviation, Inc., of Binghamton, N. Y.

Third prize was won by *Lou Dabrowski*, chemical engineer with the Canada Wire and Cable Co., of Leaside, Ontario.

Fourth prize was won by *Larry Klass*, metallurgical engineer, employed by Bendix Products Division, Bendix Aviation Corp. South Bend, Ind.

Fifth prize was won by *Charles A. Harrington*, proprietor, Cedar Rapids Metal Finishing Co., Cedar Rapids, Iowa.

Sixth prize was won by *Jack Maisel*, electroplater, employed by the Fairchild Camera & Instrument Corp. of Syosset, N. Y.

Seventh prize was won by *Gerald P. Boland*, apprentice plater employed by the Stuart-Olver-Holtz Co., of Rochester, N. Y.

Esbec Appoints Carten

Clifford G. Carten has been ap-

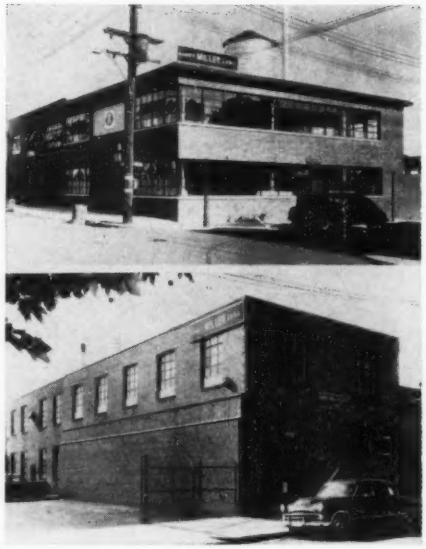
pointed regional engineer for the Southern Connecticut area by the *Esbec Barrel Finishing Corp.*, Byram, Conn. Mr. Carten moves to his new position from production manager of the firm's contract tumbling operations.

Previously, Mr. Carten was, for many years, with Singer Mfg., in Bridgeport, serving as assistant foreman of their 100-barrel tumbling department. He came to Esbec in the fall of 1952 as assistant foreman.

As a result of his wide experience, Mr. Carten brings to his new position both an expert knowledge and a practical familiarity with all phases of barrel finishing. He is in a position to offer Connecticut industry a true engineering service on all types of barrel finishing and tumbling problems.

Harry Miller Corp. Completes Plant Expansion Program

Harry Miller Corp. has recently added 33,200 square feet of space for increased production to their existing plant at 4th and Bristol Sts., Philadelphia 40, Pa. Included in the company's expansion program is the addition of



production equipment such as stainless steel mixers including a new 15 barrel stainless steel horizontal mixer. Other additions to the physical plant include the air conditioning of offices and laboratories, a new shipping dock, loading and unloading platform, outside covered storage area and a new parking lot for employees and visitors.

Platecoil Appoints Distributor

Appointment of *Process Instruments & Equipment Co.* as Platecoil distributor in the Charleston, W. Va., area has been announced by the Platecoil Division of *Tranter Mfg., Inc.*, Lansing, Mich.

Process is owned and operated by *Richard Moses*, a licensed professional engineer in the state of West Virginia. Main office of Process is at 1029 Virginia St., East. A branch, under the

Richard Moses

managership of *Ernest C. Dawson,* is maintained at 110 Knox St., Marietta, Ohio. Mr. Moses has been connected with the chemical plant equipment and instruments business since graduation from West Virginia University where he earned a BS degree in both electrical and mechanical engineering.

Mr. Moses is active in the American Society of Mechanical Engineers, the Instrument Society of America, and the West Virginia Society of Professional Engineers.

West Northcentral Rep. for Pioneer Industrial Gloves

Stanley F. Peschken, of Minneapolis, has been named West Northcentral area representative for the *Industrial Products Division* of the *Pioneer Rubber Co.,* Willard, Ohio, makers of industrial gloves.

Mr. Peschken is a life-long resident of Minnesota and has traveled extensively throughout the Minnesota, North Dakota, South Dakota and Western Wisconsin area. He is a graduate of the University of Minnesota and was formerly affiliated in a merchandising and buying capacity with Montgomery Ward in St. Paul and Gamble Skogmo, Inc., in Minneapolis.

Stanley F. Peschken

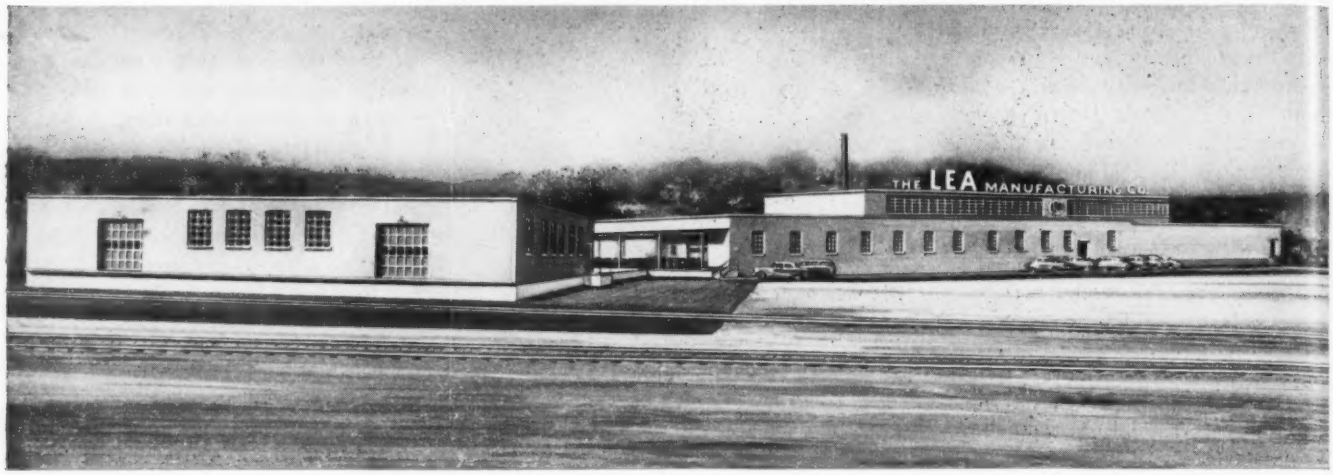
Michael Sandor Joins Nopco

Michael Sandor has joined the *Nopco Chemical Co.* as a development engineer in the Metal Processing Chemicals Department. He will concern himself in his new position with guiding the development of new chemicals for the metal and metalworking industries, demonstrating these new products in the field, and supervising the sale of them. Mr. Sandor will undertake a series of trips to various parts of the country to meet the firm's customers and discuss their metal processing problems with them.

A graduate of the Newark College of Engineering with a degree in chemical engineering, Mr. Sandor has been associated with the metal processing field in a sales engineering capacity for the past eight years.

Michael Sandor

Lea Expands New Manufacturing Facilities



Two units and a large extension in the new manufacturing plant being built by The Lea Manufacturing Company, Waterbury, Connecticut. Building No. 1 is at the left. Building No. 2 is the building with the sign. The present extension comprises about ⅓ of the building shown at the right.

The Lea Mfg. Co., Waterbury, Conn., specialists in the applications of surface finishing methods and in the manufacture of industrial abrasive finishing materials and electrochemical processes, is now operating the third section of a large new plant they are building on Aurora St. The new location consists of 14 acres and offers a rail siding plus large truck docks for better shipping facilities. Adequate room was available to design the building for more efficient operations in addition to providing ample parking facilities.

Building No. 1, erected in 1948, was designed principally as a storage unit for raw materials and for chemicals and equipment of other manufacturers for which the company acts as a distributor. Building No. 2 was completed in 1951 and is now used for the manufacture of specialties. Recently, the company completed and is now occupy-

ing a large extension to Building No. 2. This area is now devoted exclusively to the processing, packaging and handling of its well known greaseless abrasive composition. It has special storage facilities for the ingredients going into the compounds and a refrigerated room for keeping the finished compound under optimum conditions. It has modern shower, washroom and locker facilities.

All buildings in the new and expanding plant are one-level units with floors at truck level height, about 3½ feet above ground level. Buildings have reinforced concrete foundations with cinderblock curtain walls and steel trussed roof.

The 4th and last project in the building plans consists of a large office and research building. This is planned for completion in 1957.

Robertshaw-Fulton Names Assistant Director of Research

Appointment of *Charles D. Branson* as assistant director of research has been announced by *Robertshaw-Fulton Controls Co.*

He will make his office at the company's eastern research facility, at Irwin, Pa.

Charles D. Branson

Mr. Branson has been with the organization for more than 20 years. Formerly he was chief engineer at the company's Fulton Sylphon Division, Knoxville, Tenn. He has also held the positions of assistant chief engineer, development engineer and laboratory assistant, and for a time was engaged in production and inspection work.

Mr. Branson is a graduate of the University of Tennessee with a B.S. degree in mechanical engineering. He is a member of a Society of Automotive Engineers committee to standardize the use of metal bellows in aircraft. He holds patents for applying, processing and manufacturing stainless steel bellows and other bellows, as well as patents for automatic control devices used in home appliances.

National-Standard Expands, Centralizes Nickel Plating Facilities

A fifty per cent expansion of facilities for commercial production of nickel coated steel wire and consolidation of operations into the National-Standard Division in Niles, Mich. has been announced by *National-Standard Co.*

According to the announcement, plating equipment at the company's Jersey City, N. J., plant has been transferred to Niles and new facilities added to increase plating capacity to 34,000 amperes of connected direct current.

Fernicklon, the firm's registered trade name for the nickel-coated material, is produced by the improved Kenmore process. Rights to the pat-

ented process were acquired in 1955. Electrodeposition of other metals, such as copper and brass, has also proved successful.

The nickel-coated steel wire, shown above at the take-off end of the plater, is supplied in commercial sizes ranging from 0.010-inch to 0.310-inch, depending upon tensile. Extreme flexibility of the process makes possible coatings of up to 10 per cent nickel, within exceedingly narrow tolerances, even in thin coatings.

John Douglas is Appointed by Detroit Area by Jomac

John Douglas, a salesman in the safety supply field for over 15 years, has been appointed Detroit district representative for *Jomac, Inc.*, Philadelphia, Pa., manufacturers of industrial work gloves. He will head the new office in Detroit at 13156 Indiana Ave., phone TOwnsend 9-3095.

Douglas, a native of Benton, Ill., was educated in the Detroit schools. A well-known sandlot baseball player, he had a try-out with the Detroit Tigers in 1942 just before he entered the service. He served with the Engineer Corps in the Army in England, France, Belgium and Germany and has four battle stars and the Purple Heart. Douglas has been active in church music work and in radio and television.

John Douglas

Ogden to Direct New Pennsalt Operations in Mexico

Robert P. Ogden has been appointed general manager of the *Industrial Quimica Pennsalt S. A. de C. V.*, a new subsidiary of *Pennsalt International Corp.* in Mexico. This component already has a new plant under construction near Mexico City for the production of chlorine, caustic soda, muriatic acid, hydrogen and DDT.

Mr. Ogden joined the company after receiving a degree in chemical engineering at Cornell University in 1941. At the time of his appointment, he was manager of the firm's plant at Riverview, Mich.

J. J. Siefen Co. Continues School of Spraying

The J. J. Siefen Co. announces that the School of Spraying, first inaugurated in October 1954 for the buffing trade, has been most beneficial when presented to the men who work directly with automatic buffing equipment and when presented in their plant.

Any company wishing to have the school conducted in their plant may contact *Ralph Hale* at the company offices at 5657 Lauderdale, Detroit 9, Mich., for full details.

Industrial Systems Co. Appoints Kuppenheimer

Industrial Systems Co., representative of *Industrial Washing Machine*

Corp., Matawan, N. J. announces the appointment of *John D. Kuppenheimer* as Eastern sales manager and export sales manager.

News from California

By Fred A. Herr

Robert W. Lunn, formerly with Norris Thermador Co., Los Angeles, and a group of associates, recently opened a new $25,000 plant at 3348 East 14th Street, Los Angeles, to house Pacific Porcelain Products, Inc., which they organized in the fall of 1955.

The 2,400 square foot plant is equipped to specialize on customized enameling of cast iron parts, such as cooking ware, stove grates and other stove parts, and table tops and bases for restaurants. The plant is also equipped to supply color enameling of special items to customer specifications.

Major equipment items installed in the new plant include a ball mill in which the frit for porcelain is pulverized; a 7-foot open type spray booth; a 3 x 5 foot gas dryer, and a 4 x 6 foot electric furnace. Officers of the firm are Mr. Lunn, president, *Merle Campbell*, vice-president, and *Mrs. Donna Lunn*, secretary-treasurer. *Ray Corty* is plant manager.

Turco Products, Inc., recently unveiled at its Los Angeles factory the first pilot plant for use of the Chem-Mill process for etching steel and titanium aircraft parts. The new pilot plant occupies 800 square feet of floor space. The 500-gallon cleaning and etching tanks and the complementing drying oven permit processing parts up to three and four feet in length. The new etching line duplicates actual production-line conditions, it is reported, and is to be used extensively for preliminary forming of prototype parts for prospective users, and to train personnel for sublicensees of the process. Chem-Mill etching of aluminum has been in use in the Los Angeles area for several years.

The B. W. McIntyre Co., manufacturers of ball mills and special machinery for the ceramic trade, has realigned its factory at 7031 Darby Avenue, Reseda, Calif. to include a department for the design and manufacture of tumbling barrels, media and compounds.

Head of the new barrel division is *George Latshaw* who formerly owned and operated the Hydromatic Metal-finishing Co. in Cleveland, Ohio. Mr. Latshaw reports that the new division has developed its own compounds and media, and manufactures a complete line of barrel-finishing equipment and accessories. The firm's line includes finishing barrels from 6¾ by 7" diameter to 30 x 40" diameter. A commercial barrel finishing service is also offered, Latshaw reports.

Stauffer Chemical Co. of New York has acquired a 50% interest in the San Francisco Chemical Co., from The

Mountain Copper Co., Ltd., parent company of Stauffer Chemical. San Francisco Chemical Co. is reported to be a major western producer of phosphate rock and during recent year's has been Stauffer's primary supplier of that product.

P. G. Deuchler, who has been covering the Chicago territory for Handy & Harman as an industrial salesman, has been transferred to the Pacific Coast as district sales manager for the West Coast. He has been placed in charge of all sales in the area, and will serve under *Herman A. Folgner*, manager West Coast operations. Both Folgner and Deuchler make their headquarter's at the firm's Los Angeles branch office.

It was stated in this column in the July issue of METAL FINISHING that *Henry Saklad* was owner of the Sunset Plating Co. in Burbank, Calif. That statement was incorrect. The owners are *Art Habitz* and *J. V. Murray*.

The Chemical Sales Division of Charles Pfizer & Co., Inc., Brooklyn, N. Y., held a four day conference for its regional managers and field sales managers in San Francisco late in June. The sessions were attended by managers of the division's four sales regions, plus executives from Brooklyn headquarters headed by general manager *J. Philip Smith*, and sales manager *Paul E. Weber*.

Construction is underway on a new million dollar plant for the Karl-Douglas Division of Thompson Products, Inc., on a 20-acre site at 70 h St. and Downey Road, Long Beach, Calif. The 60,000 square foot building will be devoted to the production of aircraft and automotive components. The parent company, Thompson Products, Inc., of Cleveland, O., is a large maker of jet engine components, and sponsors the Thompson Trophy Race at the annual National Air Races.

OBITUARIES

FREDERIC W. WAGNER

Frederic W. Wagner, vice-president of Wagner Bros., Inc., Detroit, Mich., was killed while flying in his private plane to his summer home in Higgins Lake, Mich. Fred was the son of Mrs. A. T. Wagner and the late A. T. Wagner, who was a well-known man in the metal finishing field. Fred and his brother Joseph established Wagner Bros. in 1938. He was very well known in the metal finishing industry and was an active member of the Detroit branch of the American Electroplaters' Society.

A Frederic W. Wagner memorial

trust fund has been established. It will be used for a needy student in chemical engineering at Wayne University.

Mr. Wagner is survived by his mother, wife Bettie, six children, brother Joseph and a sister, Mrs. Edith Domine.

Erratum

The photograph published with the obituary for L. D. Cook in our August issue was inserted in error. The late Mr. Cook's picture appears herewith.

L. D. Cook

Associations and Societies

AMERICAN ELECTROPLATERS' SOCIETY

Philadelphia Branch

Philadelphia Branch will hold its annual educational session and banquet at The Benjamin Franklin Hotel, scene of the 1953 AES convention, on Saturday, October 20.

The afternoon educational session, under the direction of *Dr. A. Kenneth Graham*, president of Graham, Crowley & Associates and former AES executive secretary, will feature three papers on nickel and multiple coatings.

A banquet, show and dance will follow in the evening.

NATIONAL ASSOCIATION OF METAL FINISHERS

Plating and metal finishing job shop owners throughout the U. S. stand to receive additional nickel in the next few months, according to *Morris Ranno* of New York, nickel committee chairman of the N.A.M.F. Ranno, a partner of Imperial Plating Co., Brooklyn, one of the largest plating shops in the New York area, indicated that, in the wake of a series of hearings before the U. S. Senate Select Committee on Small Business, the long-awaited green light would be forthcoming soon from the Office of Defense Mobilization.

"The blame for today's nickel crisis rests squarely on Dr. S. Fleming, director of the ODM," said Ranno in a recent interview. "He is the single authority who could have alleviated this situation and thus have prevented hundreds of small job shops from going out of business."

Ranno described the ODM's "do-nothing policy" while the "small business men in the plating and metal finishing industry succumbs under the present unrealistic and inequitable distribution of nickel," and urged prompt, corrective action by ODM.

Following a series of conferences with officials of International Nickel Co. & National Lead Co., Ranno pointed out that there are two possible ways

by which the nickel problem can be solved:

(1) Obtain and convert nickel ore sinter and nickel oxide from the U. S.-operated Nicaro nickel fields in Cuba (Nickel ore sinter and nickel oxide can be converted into nickel anodes or nickel salts through a comparatively easy refining process);

(2) Obtain ODM authority to permit International Nickel *not* to remove job shop allocations should platers receive Nicaro nickel and, in this way, provide additional nickel to the job shop plating industry. (It is reported that Inco is amenable to such a plan but must receive authorization from ODM before it can proceed. Recently, the NAMF petitioned ODM to put into effect the above two-point plan. No word has been received as yet, according to NAMF officials.)

Hopeful of obtaining additional nickel in the near future, Ranno stated that the Dept. of Commerce will submit a preliminary report on August 15 and a final report on December 15, giving the nickel picture to Congress and urging a positive, corrective course of action.

THE NAMF, an organization of plating and metal finishing job shop owners, has expended thousands of dollars and an equal number of man hours in behalf of nickel users in the industry, according to Ranno.

"We need the continued support of member and non-member job shops alike, if we are to obtain not only the necessary nickel allocation, but the proper recognition and representation in government circles as small business men in a very vital field of commercial endeavor," concluded Ranno.

(EDITOR'S NOTE: Mr. Ranno announces that he will be happy to present the entire "nickel story" to any AES branch or other organizations. If interested, write to Morris Ranno, NAMF Nickel Committee Chairman, 100 Metropolitan Ave., Brooklyn, N. Y., for particulars.)

AMERICAN SOCIETY FOR TESTING MATERIALS

With a record registered attendance of 2896, the American Society for Testing Materials concluded its 59th Annual Meeting at Atlantic City on June 22. The Apparatus Exhibit held in conjunction with the meeting was also one of the largest ever held by the Society with 44 different exhibitors. At the week-long meeting, the Society held 32 technical sessions and approximately

NAMF Technical Advisor *S. C. Taormina*, left, smilingly approves of handsome gift of large, portable GE TV set presented recently by New York MEPA chairman *Sal Novelli* on behalf his association, at Long Island College Hospital. Taormina was hospitalized for coronary thrombosis after attending the NAMF annual meeting in Washington, D. C. in June. Hospital officials report that his condition is improving and that he is scheduled to return to his home at 453 FDR Drive, New York, for further convalescence about August 1. L to r: Taormina, Novelli, *Frank Kaiser*, secretary-treasurer, NAMF and MEPA; and *Morris Ranno*, NAMF nickel committee chairman.

700 technical committee meetings. The vigorous work of the Society's technical committees for many months was concluded with the presentation of their reports at the meeting.

Highlighting the technical program were the educational Marburg Lecture presented by *Charles E. Reed* on "The Industrial Chemistry, Properties, and Applications of Silicones;" the H. W. Gillett Memorial Lecture by *D. K. Crampton*, "Structural Chemistry and Metallurgy of Copper;" and a Symposium on Solder reported to include some of the most important discoveries on this subject for several years.

R. A. Schatzel, vice-president and director of engineering, Rome Cable Corp., was elected president of the Society for a one-year term.

Kenneth B. Woods, head, School of Civil Engineering, and director, Joint Highway Research Project, Purdue University Lafayette, Ind., was elected vice-president for a two-year term.

Richard T. Kropf, vice-president and director of research for the Belding Heminway Co., Inc., New York, continues in the office of vice-president to which he was elected last year.

Directors of the Society elected for three-year terms were:

M. N. Clair, president, The Thompson & Lichtner Co., Inc., Brookline, Mass.

H. C. Cross, metallurgist, Battelle Memorial Institute, Columbus, Ohio.

G. H. Harnden, consultant, Materials and Processes, Engineering Standards Service Engineering Services Div., General Electric Co., Schenectady, N. Y.

R. R. Litehiser, engineer of tests, Ohio State Highway Testing Lab., Columbus, Ohio.

C. R. Stock, group leader, Physical Measurements Group, American Cyanamid Co., Stamford, Conn.

THE ELECTROCHEMICAL SOCIETY, INC.

Robert M. Burns of Summit, N. J., has been selected to receive the Edward Goodrich Acheson Gold Medal and Prize of *The Electrochemical Society, Inc.* Presentation of the medal and prize of one thousand dollars will be made at a dinner to be held on October 2, 1956, at which Dr. Burns will deliver the Acheson Medal Address, at the 110th meeting of the Society in Cleveland, Ohio, September 30-October 4, 1956.

The Acheson Award is made once every two years for conspicuous "contribution to the advancement of the objects, purposes, or activities" of the Society.

Dr. Burns, formerly chemical director of Bell Telephone Laboratories, is now a scientific advisor to Stanford Research Institute and to the Sprague Electric Co.

AMERICAN SOCIETY FOR METALS

The 1956 edition of the National Metal Exposition and Congress — "the Metal Show"—to be held in Cleveland from October 8 through the 12th, will be the largest in the 38 year history of the show.

Wm. H. Eisenman, general manager, and national secretary of the Society, sponsor of the gigantic industrial assembly, reports an exhibitor roster of 465 companies whose displays will fill every one of the 250,000 square feet available in the city's huge Public Auditorium and Exhibition Halls.

Advance estimates indicate attendance at the upcoming Cleveland Show will be close to 46,000. Registration falls into three classes—members of the American Society for Metals and of associated societies, guests invited by exhibitors, and the general industrial public which may register and for only a $1.00 fee, gain admittance.

All sessions of the National Metal Congress with its program of more than 150 technical papers will be held in four hotels of the city, each a headquarters for one of the four technical societies participating in the Congress.

The American Society for Metals will be quartered at the Statler; The American Welding Society at Hotel Cleveland; the Metals Division of the American Institute of Mining, Metallurgical, and Petroleum Engineers in Hotel Carter, and the Society for Non-Destructive Testing will rally in Hotel Hollenden.

Two other societies, The Special Libraries Association, Metals Division, and the Industrial Heating Equipment Association are holding sessions concurrent with the Congress.

Hours of the show on the first three days will be from 12:00 noon to 10:30 P.M. and on the last two days from 10:00 A.M. to 6:00 P.M.

NACE

Sessions devoted to protective coatings, experimental design, analysis and application; plastics, new alloys and cermets will be held during the October 15-17 meeting at Philadelphia of Northeast Region, *National Association of Corrosion Engineers.*

The protective coatings symposium, *J. H. Cogshall*, Pennsylvania Salt Mfg. Co., chairman, will have papers on chemical surface preparation of steel, epoxy coatings and painting costs. Plastics to be discussed include Teflon, elastomeric materials of construction and plastics in the chemical industry.

Low nickel and nickel-less stainless steels, fabrication of titanium and selection of ceramics and cermets also are listed as subjects of three papers.

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1500	40/65	G. E.
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1—7500/3750 Ampere, 9/18 Volt, Hanson-Van Winkle-Munning, Synch.
1—6000/3000 Ampere, 6/12 Volt, Electric Products, Synch.
1—3000/1500 Ampere, 12/24 Volt, Chandeysson, Exc.-in-head.
1—2500/1250 Ampere, 9/18 Volt, Electric Products, Synch., Exc.-in-head. 25°C.
1—2000/1000 Ampere, 6/12 volt, Hanson-Van Winkle-Munning.
1—2000/1000 Ampere, 9/18 Volt, Electric Products.
1—1500/750 Ampere, 6/12 Volt, Hanson-Van Winkle-Munning, Synch., Exc.-in-head.
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Belke nickel plating barrels and tanks, used only 6 months, 14 x 36 Lucite cylinders, rinse, soak, and plating tanks, complete set-up can be seen in operation. Includes hoist and monorail, heat exchanger, and 1500 AMP rectifier.

STAMFORD POLISHING AND PLATING CORP.
30 Magee Ave. **Stamford, Conn.**
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SITUATIONS OPEN

BUFFING COMPOUND SALESMEN

SITUATION OPEN — Distributors, jobbers and manufacturers agents wanted to distribute and sell the full line of Schaffner's polishing and buffing composition in bar, spray or paste form, and a complete line of polishing room supplies.

SCHAFFNER MANUFACTURING COMPANY, INC.
Emsworth, Pittsburgh 2, Pa.

METAL FINISHING AND CONTROL SUPERVISOR

SITUATION OPEN—Plater capable of making up and controlling our solutions, setting up cycles for barrel plating. Wanted for medium sized manufacturing corporation. Unusual opportunity to take over complete Finishing department and all its component operations, deburring, burnishing, etc. Complete up-to-date laboratory for research and development. Include in reply business and personal background, starting salary, etc. Our personnel know of this ad. Address: September 5, care Metal Finishing, 381 Broadway, Westwood, N. J.

Wyandotte
REG. U. S. PAT. OFF.

HAS OPPORTUNITIES IN:

SALES: This major producer of metal cleaners and other chemical products for metal finishing has attractive openings for technical salesmen. Need metal finishing experience. Degree in Chemistry or Chemical Engineering preferred but not mandatory. Salary, commission and bonus, plus car and expenses. Fine opportunity for advancement in growing organization. Address Industrial Sales, J. B. Ford Division, Wyandotte Chemicals Corp., Wyandotte, Michigan.

TECHNICAL SERVICE: Opportunities for chemists or chemical engineers with at least four years experience in electroplating and metal finishing. Headquarters, Detroit area. Reply to Technical Service Department, J. B. Ford Division, Wyandotte Chemicals Corp., Wyandotte, Michigan.

RESEARCH: Responsible positions at Wyandotte, Mich., for development of detergents and other chemical products for metal finishing operations. These products used in the electrocleaning and general metal finishing fields and by the railway and aviation industries. Some experience preferable but not essential. Must have B.S. or M.S. in Chemistry or Chemical Engineering. Pleasant working conditions and modern facilities. Write Director of Application Research, Research and Engineering Division, Wyandotte Chemicals Corp., Wyandotte, Michigan.

Excellent hospitalization, insurance and retirement programs. All replies will be considered promptly and held in confidence.

WYANDOTTE CHEMICALS CORPORATION
WYANDOTTE, MICHIGAN

BUFF MANUFACTURERS AGENT

SITUATION OPEN—Active agents wanted who are now handling allied lines. Territories open include Ohio, Indiana and Michigan. We will consider exclusive territories and will support agents with extensive sales program. Complete line of buffs and polishing wheels including metal center Bias. We are long established in the East; have an excellent reputation for quality and service. We are now prepared to extend this service into the Mid-West. Replies confidential.

BARKER BROS., INC.
1660 Summerfield St. **Brooklyn 27, N. Y.**

OPPORTUNITY

Large, modern job shop has opening due to retirement of production partner. Will consider sale, new partner, or merger with other finisher or metal fabricator. Wonderful opportunity for right party. Address: September 2, care Metal Finishing, 381 Broadway, Westwood, N. J.

SITUATIONS WANTED

ELECTROPLATING CHEMIST

SITUATION WANTED—18 years experience in all types of electroplating, anodizing, conversion coatings and extensive research, development, production trouble-shooting, schedules and installations. Work also includes production process development, preparation of process specifications, customer and technical service, supervision of metal finishing and analytical laboratory personnel. B. S. Degree. Address: August 2, care Metal Finishing, 381 Broadway, Westwood, N. J.

METAL FINISHING AND QUALITY CONTROL SUPERVISOR

SITUATION WANTED—Available July 1, 1956. 13 years experience in metal finishing supervision, polishing, chrome nickel, copper, silver, zinc, etc. 7 years quality control inspection supervision on complex items. Make up and control solutions. Age 40, married, two children. Address: July 8, care Metal Finishing, 381 Broadway, Westwood, N. J.

PLATING ENGINEER

SITUATION WANTED—Well qualified plating engineer, offering twenty years diversified experience in electroplating. Now managing small manufacturing and sales company. Thoroughly experienced in sales, research, design, and supervision. Forty years old, married, free to travel. Address: April 5, care Metal Finishing, 381 Broadway, Westwood, N. J.

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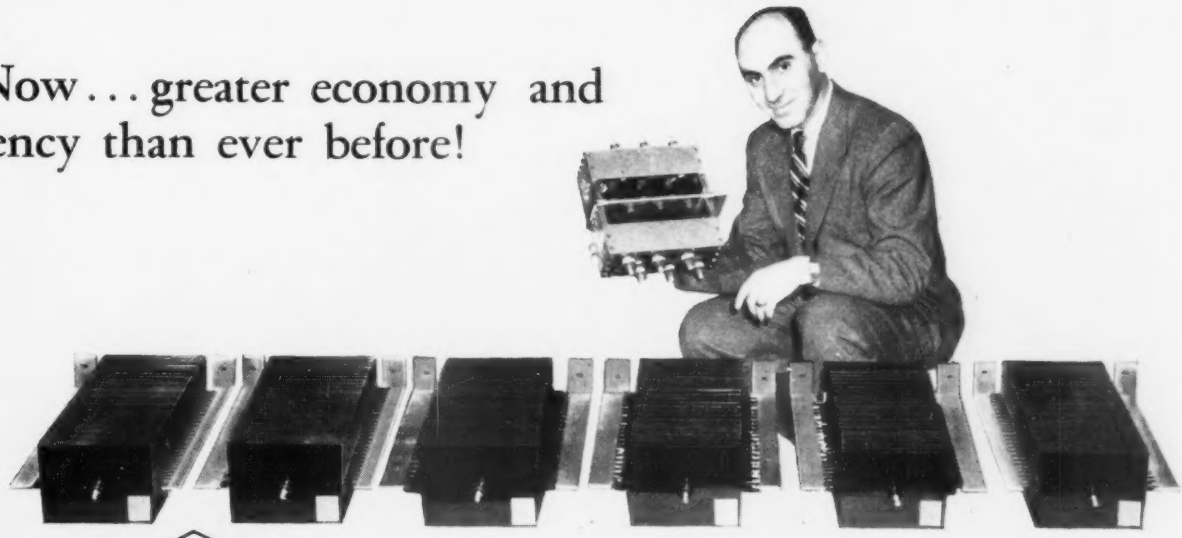

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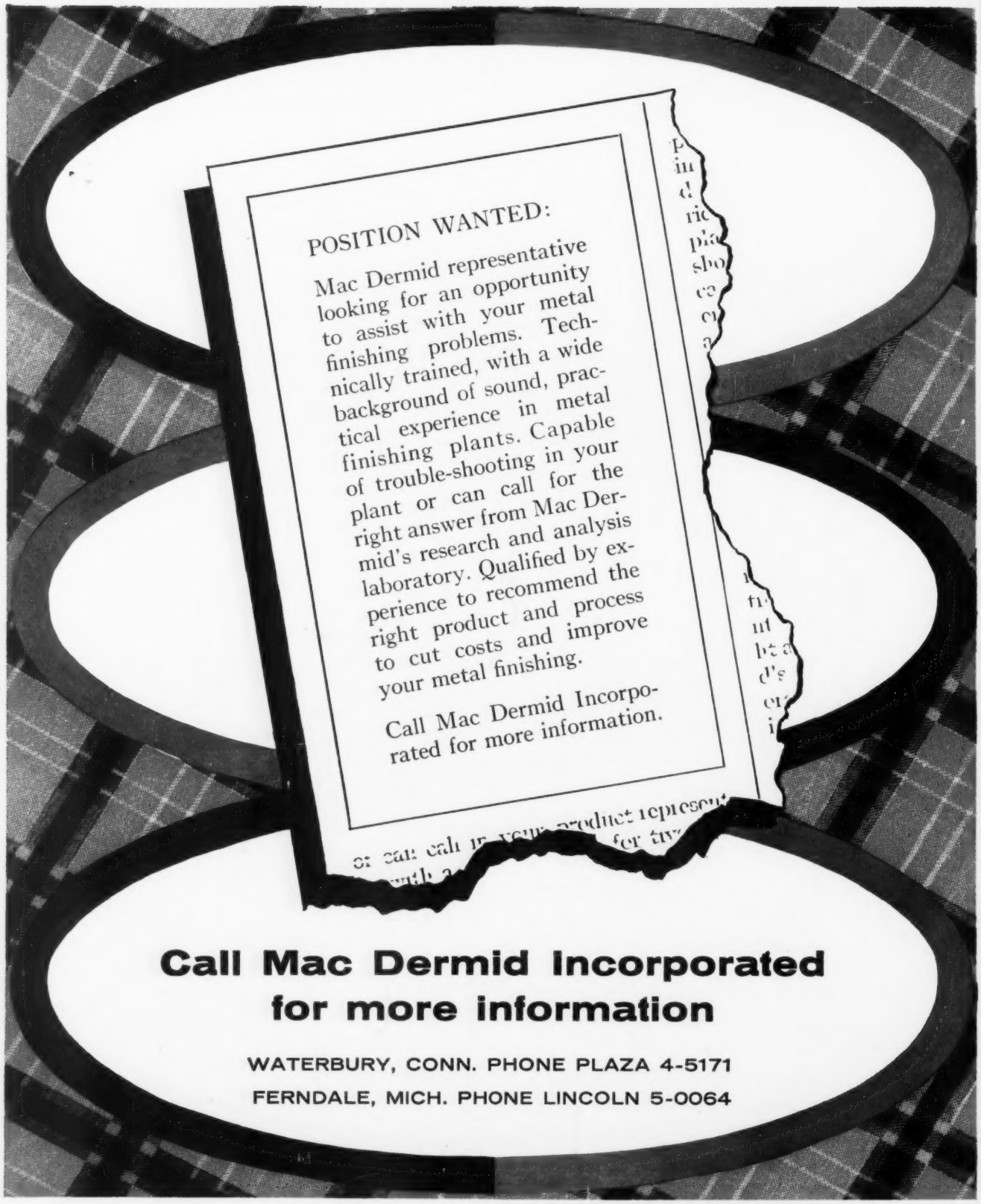

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